Final

INTEGRATED NATURAL RESOURCE MANAGEMENT PLAN

JOINT BASE PEARL HARBOR-HICKAM

Pearl Harbor Naval Complex
Naval Magazine Pearl Harbor Lualualei and West Loch Branches,
Naval Computer and Telecommunications Area Master Station Pacific Wahiawa,
Naval Radio Transmitter Facility Lualualei, Navy-retained Lands at Kalaeloa, Hickam Air Force Base
O'ahu, State of Hawai'i

Commander, Navy Region Hawaii
September 2011

Contract Cost $340,862

Integrated Natural Resources Management Plan
For
Joint Base Pearl Harbor-Hickam
O'ahu, Hawai'i

Prepared By: Natural Resources Branch
Naval Facilities Engineering Command, Pacific

Approved:

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Joint Base Pearl Harbor-Hickam
Integrated Natural Resources Management Plan
September 2011 (2011 – 2015)

Signature Page (Pacific Islands Fish and Wildlife Office, U.S. Fish & Wildlife Service)

This Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan (INRMP) supersedes all previous INRMPs for Navy properties on the island of Oahu and Hickam Air Force Base.

The Sikes Act Improvement Act 1997requires that the proposed INRMP be prepared in cooperation and partnership with the U.S. Fish & Wildlife Service and the State fish and wildlife agency and that the management of fish and wildlife in the proposed INRMP reflects mutual agreement of Sikes Act partners. Department of Defense policy requires that NOAA Fisheries Service is also a partner and cooperating agency with INRMPs covering marine resources.

The U.S. Fish and Wildlife Service, Hawaii Division of Forestry and Wildlife, and NOAA Fisheries Service, by signature or an enclosed letter of agreement from their agency representative, grant their concurrence and acceptance of this document.

Approving Official:

(*See Appendix M1, July 12, 2012 USFWS Letter of Agreement*)

Dr. Loyal Mehrhoff Date
Field Supervisor
United States Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office

Joint Base Pearl Harbor-Hickam
Integrated Natural Resources Management Plan
September 2011 (2011 – 2015)

Signature Page (State of Hawaii Division of Forestry and Wildlife)

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Approving Official:

Randy Kennedy, Acting Administrator 2/11/14

for Roger Imoto
Administrator
Division of Forestry and Wildlife
Department of Land and Natural Resources
State of Hawaii

Date

* Please see attached comments

Final
Integrated Natural Resource Management Plan

Joint Base Pearl Harbor-Hickam

Pearl Harbor Naval Complex
Naval Magazine Pearl Harbor Lualualei and West Loch Branches,
Naval Computer and Telecommunications Area Master Station Pacific Wahiawa, Naval Radio Transmitter Facility Lualualei,
Navy-retained Lands at Kalaeloa, and Hickam Air Force Base
O‘ahu, State of Hawai‘i

Prepared for:
Commander, Navy Region Hawaii

Prepared by:
Naval Facilities Engineering Command, Pacific
and
Helber Hastert & Fee Planners, Inc.

September 2011

“What happens in our environment and to our natural resources is a matter of national security. What happens in our environment cannot be dealt with at some later date; it must be addressed now, and we must keep it on our minds constantly,"

Admiral Gary Roughead, Chief of Naval Operations
May 28, 2009

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ACRONYMS AND ABBREVIATIONS

°	degree(s)
ac	acre(s)
ADP	Automated Data Processing
AFB	Air Force Base
AFS	Air Force Station
AFV	alternative fuel vehicles
AICUZ	Air Installation Compatible Use Zones
AIS	Aquatic Invasive Species
APHIS	Animal and Plant Health Inspection Service
AST	aboveground storage tank
AT/FP	Anti-Terrorism/Force Protection
BAM	Baseline Assessment Memorandum
BASH	bird aircraft strike hazard
BMPs	best management practices
BOA	basic ordering agreements
BRAC	Base Realignment and Closure
BS	Beach Sand
BUMED	Navy Bureau of Medicine and Surgery
BY	Budget Year
C0	Class 0
C1	Class 1
C2	Class 2
C3	Class 3
C	Celsius
CAA	Clean Air Act
CCH	City and County of Honolulu
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Compensation and Liability Act
CESG	Combined Exercises Support Group
CFC	Chlorofluorocarbons
CFR	Code of Federal Regulations
CH	critical habitat
Cl^-	chlorides
CITES	Convention on International Trade in Endangered Species
cm	centimeter(s)
cm/sec	centimeter(s) per second
CNIC	Commander Navy Installation Command
CNMI	Commonwealth of the Northern Mariana Islands
CNO	Chief of Naval Operations
CNRH	Commander, Navy Region Hawaii
CO	darbon monoxide
COMPACFLT	Commander, Pacific Fleet
COMNAVFACENGCOM	Commander, Naval Facilities Engineering Command
COMNAVMARIANAS	Commander, Naval Forces Marianas
COMNAVSEASYSCOM	Commander, Naval Sea Systems Command
COMNAVSECGRU	Commander, Naval Security Group
CPNAB	Contractors Pacific Naval Bases
CPO	Chief Petty Officers
CR	Coral Outcrop
CWA	Clean Water Act
CY	Calendar Year
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act

DAR	Division of Aquatic Resources
DBEDT	Department of Business, Economic Development, and Tourism
DECA	Defense Commissary Agency
DHHL	Department of Hawaiian Homelands
DLNR	Department of Land and Natural Resources
DOCFH	Directorate of 'Oahu Consolidated Family Housing
DOFAW	Division of Forestry and Wildlife
DOD	Department of Defense
DODI	Department of Defense Initiative
DOE	Department of Energy
DOH	Department of Health
DON	Department of the Navy
DOT	State Department of Transportation
DRMO	Defense Reutilization and Marketing Offices
E	endangered
EA	Environmental Assessment
EaB	'Ewa silty clay loam, 3 to 6 percent slopes
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EHS	extremely hazardous substance
EIS	Environmental Impact Statement
EmA	'Ewa silty clay, 0 to 1 percent slopes
EmB	'Ewa silty clay moderately shallow, 2 to 6 percent slopes
EMR	electromagnetic radiation
EO	Executive Order
EOD	explosive ordnance disposal
EPACT	Energy Policy Act
EPCRA	Emergency Planning and Community Right-to-Know Act
EPR	Environmental Program Requirements
ERL	Environmental Readiness Level
ESA	Endangered Species Act
ESQD	explosives safety quantity distance
ESSM	Emergency Ship Salvage Material
EwC	'Ewa stony silty clay, 6 to 12 percent slopes
F	Fahrenheit
F-76	military diesel fuel
FCMC	Forest City Military Communities, LLC
Fd	Fill land
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FFD	Federal Fire Department
FFS	French Frigate Shoals
FHU	family housing units
FISC	Fleet and Industrial Supply Center
FISCPH	Fleet and Industrial Supply Center Pearl
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FIRM	Flood Insurance Rate Map(s)
FL	Fill land mixed
Fleet	Commander, Pacific Fleet
FMP	fishery management plan
FOSC	Federal On-Scene Coordinator
FOTW	Federally Owned Treatment Works
FR	Federal Register
FRP	Facility Response Plan
ft	foot (feet)
FY	fiscal year

GIS	Geographic Information System
GOCO	Government-Owned, Contractor-Operated
GPS	global positioning system
ha	hectare(s)
HAZWOPER	Hazardous Waste Operations and Emergency Response
HeA	Haleiwa silty clay, 0 to 2 percent slopes
HeB	Haleiwa silty clay, 2 to 6 percent slopes
HECO	Hawaiian Electric Company
HERO	Hazards of Electromagnetic Radiation to Ordnance
HERP	Hazards of Electromagnetic Radiation to Personnel
HFD	Honolulu Fire Department
HHF	Helber Hastert & Fee Planners, Inc.
HIANG	Hawaii Air National Guard
HLMG	Helemano silty clay, 30 to 90 percent slopes
HnB	Hanalei silty clay, 2 to 6 percent slopes
HNHP	Hawaii National Heritage Program
HPD	Honolulu Police Department
HRCMP	Hawaii Range Complex Monitoring Plan
HRSOC	Hawaii Regional Security Operations Center
HS	hazardous substances
HW	hazardous waste
HxA	Honouliuli clay, 0 to 2 percent slopes
HxB	Honouliuli clay, 2 to 6 percent slopes
ICP	Interagency Contingency Plan
ICRMP	Integrated Cultural Resource Management Plan
IEPM	Installation Environmental Program Manager
I/M	Inspection/Maintenance
IMF	Intermediate Maintenance Facility
in	inch(es)
INACTSERVCRAF	Inactive Service Craft Facility
INACTSHIPFAC	Inactive Ship Facility
INACTSHIPMAINTO	Inactive Ships Maintenance Office
INRMP	Integrated Natural Resources Management Plan
IPM	Integrated Pest Management
IRP	Installation Restoration Program
JaC	Jaucas sand, 0 to 15 percent slopes
JBPHH	Joint Base Pearl Harbor-Hickam
JP-5	Jet Propellant-5 (jet fuel)
JP-8	Jet Propellant-8 (jet fuel)
KanE	Kaena very stony clay, 10 to 35 percent slopes
KfB	Kaloko clay, non calcareous variant
KlaA	Kawaihāpai stony clay loam, 0 to 2 percent slopes
KlaB	Kawaihāpai stony clay loam, 2 to 6 percent slopes
KlaC	Kawaihāpai very stony clay loam, 2 to 7 percent slopes
KlcB	Kawaihāpai silty clay loam, 2 to 7 percent slopes
km	kilometer(s)
Km^2	square kilometer(s)
KmA	Kea'au clay, 0 to 2 percent slopes
KmaB	Kea'au stony clay, 0 to 2 percent slopes
KmbA	Kea'au clay, saline 0 to 2 percent slopes
KTKE	Kokahi stony clay, 0 to 35 percent
LaC	Lāhainā silty clay, 7 to 15 percent slopes
LaC3	Lāhainā silty clay, severely eroded, 7 to 15 percent slopes
LeB	Leilehua silty clay, 2 to 6 percent slopes
LeC	Leilehua silty clay, 6 to 12 percent slopes
LEPC	Local Emergency Planning Committee

LOGREQ	logistics requirements
Lot 58-B	Lot 13058-B
Lot 58-D	Lot 13058-D
Lot 58-F	Lot 13058-F
Lot 58-G	Lot 13058-G
Lot 73-A	Lot 13073-A
Lot 74-D	Lot 13074-D
LuA	Lualualei clay, 0 to 2 percent slopes
LuB	Lualualei clay, 2 to 6 percent slopes
LvA	Lualualei stony clay, 0 to 2 percent slopes
LvB	Lualualei extremely stony clay, 2 to 6 percent slopes
LPE	Lualualei extremely stony clay, 3 to 35 percent slopes
LUC	Land Use Commission
MARAD	Maritime Administration
MBTA	Migratory Bird Treaty Act of 1918
MCAS	Marine Corps Air Station
MdB	Makalapa clay, 2 to 6 percent slope
MdC	Makalapa clay, 6 to 12 percent slope
MdD	Makalapa clay, 12 to 20 percent slope
MDSU	Mobile Diving Salvage Unit
MERIT	Materials of Evolving Regulatory Interest Team
m	meter(s)
mgd	million gallons per day
mg/L	milligrams per liter
MHI	Main Hawaiian Islands
mi	mile(s)
mi^2	square miles(s)
mld	million liters per day
mm	millimeter
MMPA	Marine Mammal Protection Act
MnC	Māmala stony silty clay loam, 0 to 12 percent slopes
MOA	Memorandum of Agreement
MoB	Manana silty clay loam, 2 to 6 percent slopes
MoC	Manana silty clay loam, 6 to 12 percent slopes
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MpD2	Manana silty clay loam, 12 to 25 percent slopes
MS4	municipal separate storm sewer system
MSA	Magnuson-Stevens Act
MSC	Moanalua Shopping Center
msl	mean sea level
Mtb	Mokuleia Clay
MuB	Moloka'i silty clay, 3 to 7 percent slopes
MuC	Moloka'i silty clay loam, 3 to 7 percent slopes
MWR	Morale, Welfare, and Recreation Department
NAAQS	National Ambient Air Quality Standards
NAD	Naval Ammunition Depot
NAS	Naval Air Station
NASBP	Naval Air Station Barbers Point
NAVCOMSTA	Naval Communication Station
NAVFAC	Naval Facilities Engineering Command
NAVFAC HI	Naval Facilities Engineering Command Hawaii
NAVFAC PAC	Naval Facilities Engineering Command Pacific
NAVMAG PH	Naval Magazine Pearl Harbor
NAVSEA	Naval Sea Systems Command
NAVSEADET	Naval Sea Systems Command Detachment

NAVSTA PH	Naval Station Pearl Harbor
NAVSUP	Naval Supply Systems Command
Navy	Department of the Navy
NCN	no common name
NCP	National Contingency Plan
NCTAMS EASTPAC	Naval Communications Area Master Station, Eastern Pacific
NCTAMSPAC	Naval Computer and Telecommunications Area Master Station Pacific
NDSA	Naval Defensive Sea Area
NEPA	National Environmental Policy Act
NESCOM	Navy Exchange Service Command
NESHAPS	National Emissions Standards for Hazardous Air Pollutants
NEX	Navy Exchange
NFESC	Naval Facilities Engineering Service
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NISMF	Naval inactive Ship Maintenance Facility
NISMO	Inactive ships on-site maintenance office
nm	nautical mile
NMC EAD DET NS PH WL	Navy Munitions Command East Asia Division Detachment Pearl Harbor, Naval Station Pearl Harbor West Loch Annex
NMC EAD DET NS PH LLL	Navy Munitions Command East Asia Division Detachment Pearl Harbor, Naval Station Pearl Harbor Lualualei Annex
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	NOAA National Marine Fisheries Service
NOC	normal operating costs
NOSC	Navy Operational Support Center
NOTW	Navy-owned treatment works
NOx	nitrogen oxide
NRC	National Response Center
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NRMP	Natural Resources Management Plan
NRT	National Response Team
NRTF	Naval Radio Transmitter Facility
NTSR	Northern Trap and Skeet Range
NUWC	Naval Underwater Warfare Center
NWHI	Northwest Hawaiian Islands
NWI	National Wetland Inventory
O3	ozone
ODS	ozone-depleting substances
OEBGD	Overseas Environmental Baseline Guidance Document
OEIS	Overseas Environmental Impact Statement
OHS	Oil/Hazardous Substance
OISC	O'ahu Invasive Species Committee
O&MN	Operations and Maintenance, Navy
OMB	Office of Management and Budget
OPA 90	Oil Pollution Act of 1990
OPCON	Operational Control
OPNAVINST	Office of the Chief of Naval Operations Instruction
OR & L	O'ahu Railway and Land Company
OSHA	Occupational Health & Safety Administration
OW/WO	Oily Waste/Waste Oil
P0	Priority zero (0)
P1	Priority one (1)

P2	Priority two (2)
P3	Priority three (3)
PaC	Paaloa silty clay, 3 to 12 percent slopes
Pan Am	Pan American Airways
PE	Professional Engineer
Ph	Pearl Harbor Clay
PH	Pearl Harbor
PHEC	Pearl Harbor Entrance Channel
PHMSA	Pipeline and Hazardous Materials Safety Administration
PHNC	Pearl Harbor Naval Complex
PHNWR	Pearl Harbor National Wildlife Refuge
PHR	Pearl Hermes Reef
PHNSY	Pearl Harbor Naval Shipyard
PIH	plug-in hybrid
PL	Public Law
PMRF	Pacific Missile Range Facility
POL	Petroleum, oil, lubricants
POM	Program Objective Memorandum
PPBES	Planning Programming and Budgeting and Execution System
ppm	parts per million
ppt	parts per thousand
PPV	Public-Private Venture
PR	Program Review
PrY	Program Year
PsA	Pulehu clay loam, 0 to 3 percent slopes
PTR	Public Transportation Route
PuB	Pulehu stony clay loam, 2 to 6 percent slopes
PvC	Pulehu very stony clay loam, 0 to 12 percent slopes
PWC	Public Work Center
PY	Prior Year
QRP	Qualified Recycling Program
RCRA	Resource Conservation and Recovery Act of 1976
RFI	Radio Frequency Interference
RI	Remedial Investigation
RIMPAC	Rim of the Pacific
rRK	Rockland
RPM	Remedial Project Manager
RSIP	Regional Shore Infrastructure
rTP	tropohumults-Dystrandepts Association
rST	Stony land
SAIA	Sikes Act Improvement Amendments of 1997
SARA	Superfund Amendments and Reauthorization Act of 1986
SCP	Spill Contingency Plan
seq.	sequence
SECNAV	Secretary of the Navy
SERC	State Emergency Response Commission
Shipyard	Pearl Harbor Naval Shipyard
SHPO	State Historic Preservation Officer
SIHP	State Inventory of Historic Places
SIMA	Shore Maintenance Activities
SMA	Special Management Areas
SO2	sulfur dioxide
SOH	State of Hawai'i
SOP	standard operating procedure
SPCC	Spill Prevention Control and Countermeasure
ST	storage tanks

STSR	Southern Trap and Skeet Range
SUBASE	Submarine Base
SUPSALV	Supervisor of Salvage and Diving
T	threatened
TMDL	total maximum daily load
TR	Tropoquepts
UIC	underground injection control
UNDET	underwater training area
UNDS	Uniform National Discharge Standards
U.S.	United States
USACE	U.S. Army Corps of Engineers
U.S.C.	U.S. Code
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USNS	U.S. Naval Ship
USS	U.S. Ship
UST	Underground Storage Tank
UWSH	Underwater Ships Husbandry
WaA	Wahiawa silty clay, 0 to 3 percent slopes
WS	Wildlife Services
WQLS	Water Quality Limited Segment
WWTP	Wastewater Treatment Plant
WzA	Waipahu silty clay, 0 to 2 percent slopes
WzB	Waipahu silty clay, 2 to 6 percent slopes
WzC	Waipahu silty clay, 6 to 12 percent slopes
XO	Executive Officer

Place Name Key for JBPHH INRMP

Area name used in INRMP	INRMP study area	Official area name
Beckoning Point	Pearl Harbor Naval Complex (Figures 3-1 though 3-7, Table 3-1)	N/A
Bishop Point	"	N/A
Catlin Park Housing Community	"	Catlin Park, Forest City Military Communities (FCMC) Hawaii
Doris Miller Park Housing Community	"	Doris Miller Park, FCMC Hawaii
FFD	"	Naval Station (NAVSTA) Pearl Harbor Federal Fire Department (FFD)
Ford Island	"	N/A
Ford Island Housing Community	"	Battleship Cove, FCMC Hawaii
Ford Island Housing Community	"	Ford Island Landing, FCMC Hawaii
Ford Island Housing Community	"	Kamehameha Loop, FCMC Hawaii
Ford Island Housing Community	"	Luke Field, FCMC Hawaii
Ford Island Housing Community	"	Nob Hill, FCMC Hawaii
Fort Kamehameha WWTP	"	NAVFAC Hawaii, Fort Kamehameha Waste Water Treatment Plant (WWTP)
Halawa Housing Community	"	Halawa, FCMC Hawaii
Hale Alii Housing Community	"	Hale Alii, FCMC Hawaii
Hale Moku Housing Community	"	Hale Moku, FCMC Hawaii
Halsey Terrace Housing Community	"	Halsey Terrace, FCMC Hawaii
Hokulani Housing	Pearl Harbor Naval	Hokulani, FCMC Hawaii

Place Name Key for JBPHH INRMP

Area name used in INRMP	INRMP study area	Official area name
Community	Complex (Figures 3-1 though 3-7, Table 3-1)	
Hospital Point Housing Community	"	Hospital Point, FCMC Hawaii
Iroquois Point/Puuloa Housing Community	"	The Waterfront at Puuloa
Intertidal Areas and Waters of Pearl Harbor	"	N/A
Little Makalapa Housing Community	"	FCMC Hawaii
MSC/NEX/Commissary	"	Navy Exchange (NEX) Pearl Harbor, Navy Exchange Service Command (NESCOM)
MSC/NEX/Commissary	"	Pearl Harbor Commissary, Defense Commissary Agency (DECA)
Makalapa Crater	"	N/A
Makalapa Housing Community	"	Makalapa, FCMC Hawaii
Maloelap Housing Community	"	Maloelap, FCMC Hawaii
Manana Housing Community	"	Manana, FCMC Hawaii
Marine Barracks Housing Community	"	Marine Barracks, FCMC Hawaii
McGrew Point Housing Community	"	McGrew Point, FCMC Hawaii
Moanalua Terrace Housing Community	"	Moanalua Terrace, FCMC Hawaii
NAVMAG PH West Loch	"	Navy Munitions Command East Asia Division Detachment Pearl Harbor, Naval Station Pearl Harbor West Loch Annex (NMC EAD DET NS PH WL)

Place Name Key for JBPHH INRMP

Area name used in INRMP	INRMP study area	Official area name
NISMO	Pearl Harbor Naval Complex (Figures 3-1 though 3-7, Table 3-1)	Inactive Ships Maintenance Office (INACTSHIPMAINTO) Pearl Harbor, HI, Naval Sea Systems Command (NAVSEA)
Naval Station	"	Naval Station (NAVSTA) Pearl Harbor
Naval Station (SUBASE)	"	Naval Submarine Support Command (NSSC), Pearl Harbor, HI
Naval Station (FISC)	"	Fleet and Industrial Supply Center Pearl (FISCPH), Naval Supply Systems Command (NAVSUP)
Navy-Marine Golf Course	"	Navy-Marine Golf Course
Ohana Nui	"	N/A
Pearl City Peninsula	"	N/A
Pearl City Peninsula Housing Community	"	Pearl City Peninsula, FCMC Hawaii
Public Works Center Compound	"	NAVFAC Hawaii
Radford Terrace Housing Community	"	Radford Terrace, FCMC Hawaii
Red Hill Storage Area	"	Red Hill Fuel Storage Facility
Red Hill Housing Community	"	Red Hill Terrace, FCMC Hawaii
Richardson Recreation Center and Aiea Landing	"	N/A
Salt Lake Storage Area	"	N/A
Shipyard	"	Pearl Harbor Naval Shipyard (PHNSY), Naval Sea Systems Command (NAVSEA)
Waiawa Watershed	"	NAVFAC Hawaii Waiawa Water Pumping Station
Waipio Peninsula	Pearl Harbor Naval Complex (Figures 3-1 though 3-7, Table 3-1)	Navy Munitions Command East Asia Division Detachment Pearl Harbor, Naval Station Pearl Harbor West Loch Annex (NMC EAD DET NS PH WL)

Place Name Key for JBPHH INRMP

Area name used in INRMP	INRMP study area	Official area name
NAVMAG PH Lualualei	Lualualei (Figure 4-1)	Navy Munitions Command East Asia Division Detachment Pearl Harbor, Naval Station Pearl Harbor Lualualei Annex (NMC EAD DET NS PH LLL)
NRTF Lualualei	"	Naval Radio Transmitter Facility (NRTF) Lualualei
Camp Stover Housing Community	NCTAMSPAC Wahiawa (Figure 5-1)	Camp Stover, FCMC Hawaii
NCTAMSPAC Wahiawa	"	Naval Computer Telecommunications Area Master Station Pacific (NCTAMS PAC)
Barbers Point Golf Course and Stables	Kalaeloa (Figure 6-1)	Barbers Point Golf Course Barbers Point Stables
Biosolids Treatment Facility	"	NAVFAC Hawaii Biosolids Treatment Facility, Kalaeloa
DRMO	"	Defense Reutilization and Marketing Office Hawaii
NAVFAC HI West Oahu Shops	"	N/A
Nimitz Beach and Cottages	"	Nimitz Beach
Nimitz Beach and Cottages	"	Nimitz Beach Cottages
Nimitz Beach and Cottages	"	Nimitz Cove
Nimitz Beach and Cottages	"	Nimitz Cove Cottages
White Plains Beach and Cottages	"	White Plains Beach
White Plains Beach and Cottages	"	White Plains Beach Cottages

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

1. INTRODUCTION

This Integrated Natural Resources Management Plan (INRMP) has been developed for the United States (U.S.) Department of the Navy (Navy or DON), Commander, Navy Region Hawaii (CNRH) for its Joint Base Pearl Harbor-Hickam (JBPHH), O'ahu (Figure ES-1 and Table ES-1) to meet statutory requirements of the Sikes Act Improvement Act (SAIA) of 1997 (16 U.S. Code [U.S.C.] 670(a) *et sequitor* Public Law 105-85). This INRMP is one of two CNRH INRMPs. The other INRMP is for the Pacific Missile Range, which consists of several distinct land areas within Kaua'i and Honolulu Counties, State of Hawai'i (SOH).

The primary purpose of this INRMP is to update the 2001 INRMPs for Pearl Harbor Naval Complex (PHNC), Naval Magazine Pearl Harbor (NAVMAG PH), and Naval Computer and Telecommunications Area Master Station Pacific (NCTAMSPAC) Wahiawa and to update the 1997 Natural Resources Management Plan for Navy-retained land at the former Naval Air Station Barbers Point (now known as Kalaeloa[1]). Hickam Air Force Base (AFB) came under Navy control as of October 1, 2010 as a result of the Joint-Basing process. Natural resource management at Hickam has been covered in an Air Force INRMP covering all previously held Air Force properties in Hawai'i (U.S. Air Force 2007). The sections pertaining to those properties that are now under Navy jurisdiction have been extracted and inserted in Chapter 7 of this INRMP.

The plan provides a framework where natural resources are managed in accordance with the SAIA mandate to provide "no net loss in the capability of military installation lands to support the military mission of the installation." This INRMP serves three main functions: (1) it serves as an information repository for natural resource information, assets, and constraints; (2) it provides guidance on how JBPHH is to comply with federal laws, rules, regulations, executive orders, and Department of Defense and Navy directives relating to natural resources; and (3) it identifies management goals, required actions, and resources necessary to protect and manage the installation's natural resources to provide the flexibility required to maintain "no net loss capability".

Chapters 1 and 2 describe the purpose and scope of the INRMP, as well as the management strategies for its implementation. The plan requires a 5-year update and annual review. Natural Resources Management uses an ecosystem management approach, with special consideration to protected species and rare habitats. An adaptive management strategy is described, whereby ongoing natural resources surveys are used to guide, and potentially change, the management actions required. The JBPHH Installation Environmental Program Manager (IEPM), and natural resources staffs at Naval Facilities Engineering Commands Hawaii and Pacific (NAVFAC HI and NAVFAC PAC) and Commander Pacific Fleet (COMPACFLT) are responsible for implementing the INRMP. The INRMP is developed, updated, and reviewed in cooperation with the SAIA partners: U.S. Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries (Fisheries), and SOH Department of Land and Natural Resources (DLNR).

[1] Place names for NAVSTA PH INRMP are listed in a place name key at the beginning of this plan (see table of contents) which provides the official names for these land areas.

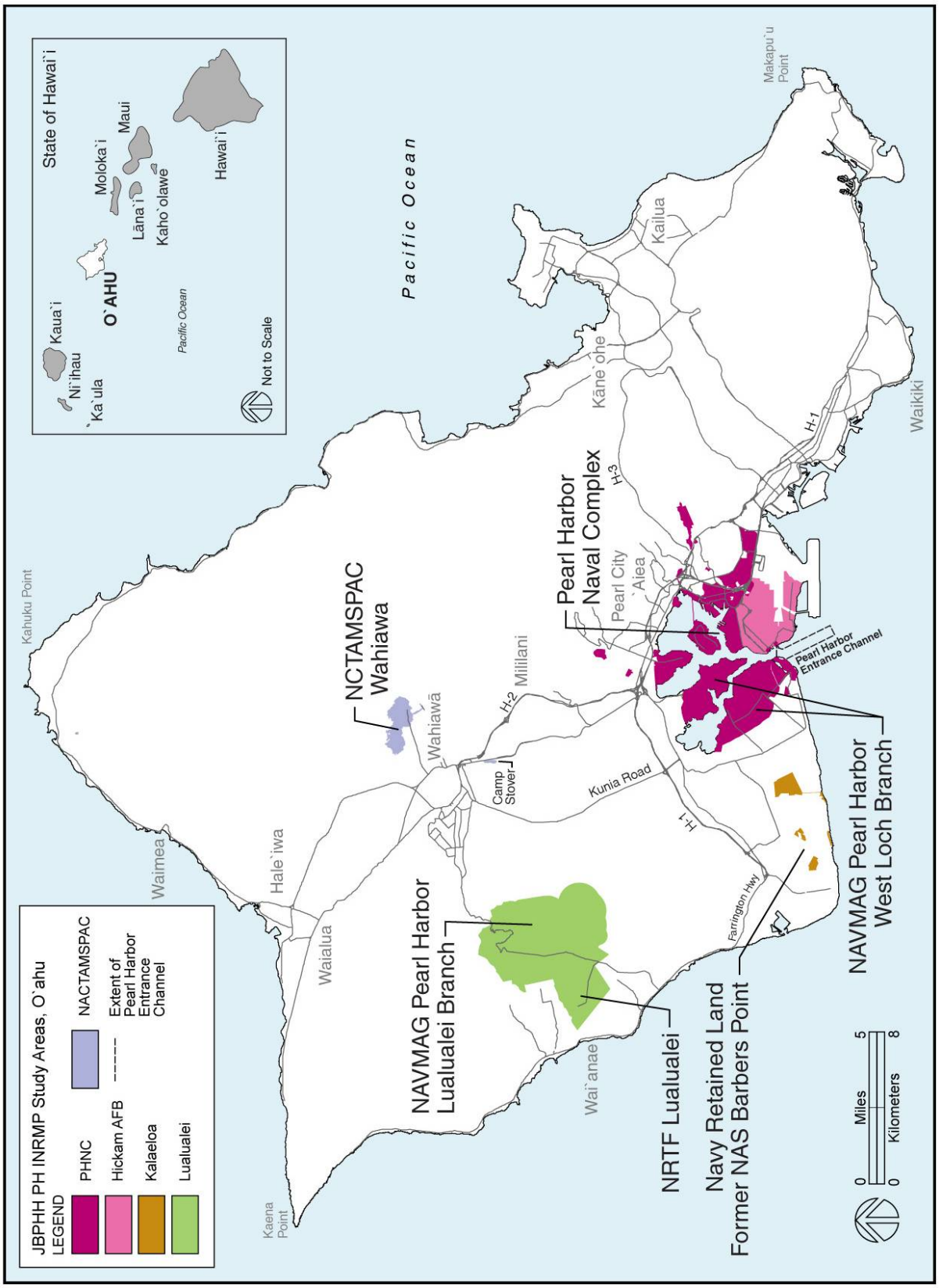


Figure ES-1: JBPHH Study Area, O'ahu

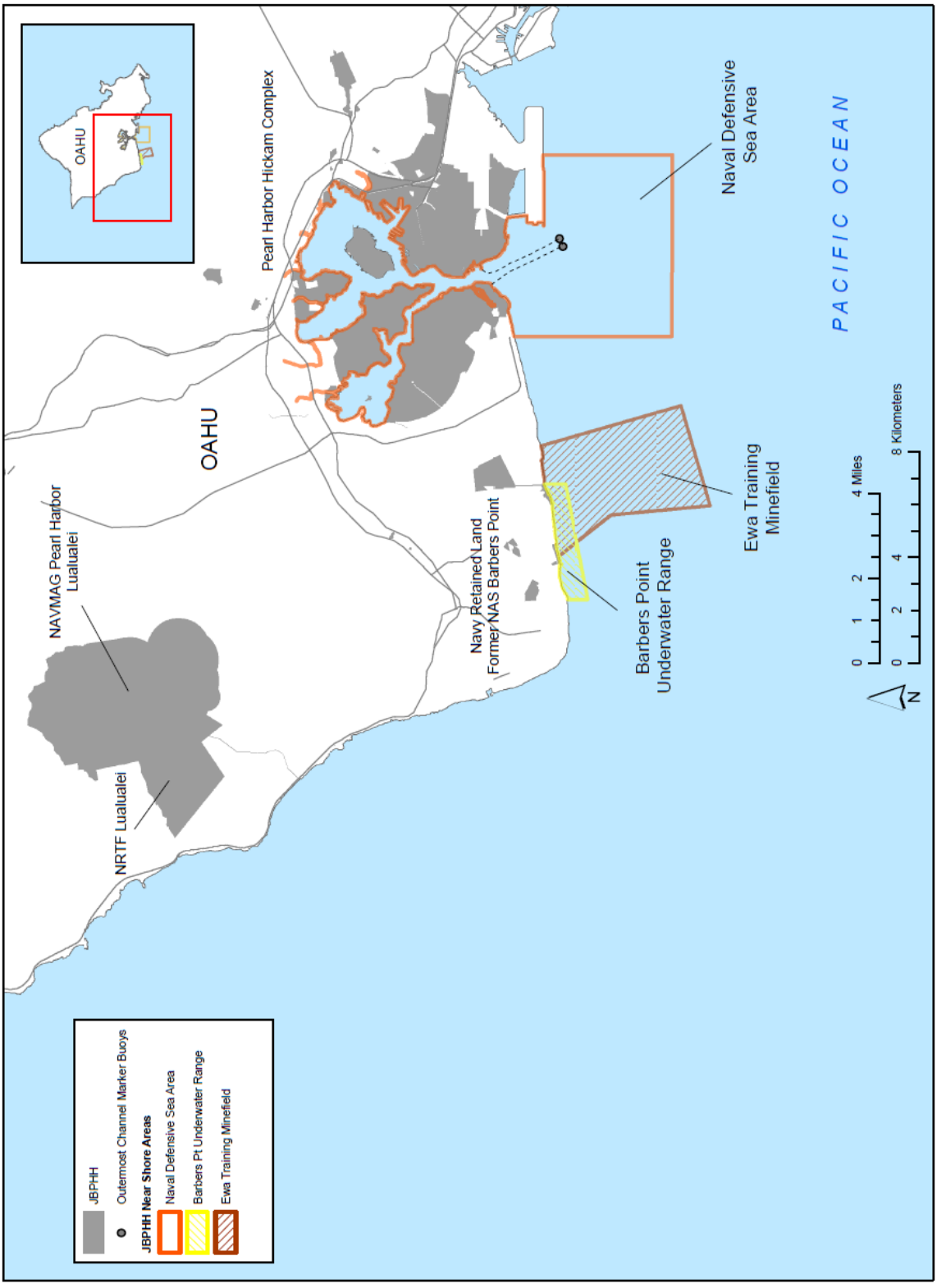


Figure ES-2: Naval Defensive Sea Area and Off Shore Training Areas, O'ahu

Table ES-1: Lands and Waters Owned, Leased or Otherwise Controlled by JBPHH, O'ahu

INRMP Study Area	Approximate Land Area in ac (ha)	Land Ownership	Land Use and Types of Operations	Requires a Natural Resources Management Plan
PHNC	Approximately 6,982 acres (ac) (2,826 hectares [ha]) land and approximately 68,081 ac (27,552 ha) of water	Navy	Areas with Significant Natural Resources: (1) intertidal areas and waters of Pearl Harbor, the Naval Defensive Sea Area, and offshore training areas (Figure ES-2); (2) undeveloped portions of Makalapa Crater[2]; (3) undeveloped portions of Pearl City Peninsula; (4) undeveloped portions of Red Hill Storage Area; (5) undeveloped portions of Waiawa Watershed; and (6) undeveloped portions of NAVMAG PH West Loch Branch (including Waipio Peninsula. The intertidal areas and waters of Pearl Harbor are used for ship berthing, maintenance, and repair as well as recreation; the Makalapa Crater, excluding family housing, is an administrative complex; Pearl City Peninsula, excluding family housing, is primarily used for warehousing, operations, and wildlife refuge; Red Hill Storage area is primarily used for supply and public works; and Waiawa Watershed is primarily used for supply and public works. NAVMAG PH West Loch Branch contains 4,082 ac (1,652 ha) including magazines, operations and maintenance buildings, community and personnel support, wharves for loading and unloading of explosives and other military ordnance and materiel, and open lands within the established explosives safety quantity distance (ESQD) arcs.	Yes, includes federally-listed birds, marine mammals, and sea turtles; Migratory Bird Treaty Act (MBTA)-protected birds; wildlife refuges; wetlands; and outdoor recreation areas. Includes historic fishponds.

[2] Place names for JBPHH INRMP are listed in a place name key at the beginning of this plan (see table of contents) which provides the official names for these land areas.

Table ES-1: Lands and Waters Owned, Leased, or Controlled by JBPHH (Continued)

INRMP Study Area	Approximate Land Area in ac (ha)	Land Ownership	Land Use and Types of Operations	Requires a Natural Resources Management Plan
PHNC (continued)	Approximately 1,953 ac (790 ha)	Navy	Highly Developed and Industrialized Areas: (1) Beckoning Point; (2) Bishop Point; (3) Federal Fire Department (FFD); (4) Ford Island; (5) Fort Kamehameha Wastewater Treatment Plant (WWTP); (6) Moanalua Shopping Center (MSC)/Navy Exchange (NEX)/Commissary; (7) Naval Sea (NAVSEA) Inactive Ships On-Site Maintenance Office (NISMO); (8) Naval Station; (9) Navy-Marine Golf Course; (10) Ohana Nui; (11) Public Works Center Compound; (12) Richardson Recreation Center and 'Aiea Landing; (13) the Salt Lake Storage Area; and (14) the Pearl Harbor Naval Shipyard (Shipyard)(shown on Figure 3-6). Although most of the operational facilities are consolidated in the highly developed core fronting Southeast Loch, other land areas around the harbor are used for supply, recreation, other operations, logistic support including ship berthing, repair and maintenance, supply and storage, and public works support.	Yes, contains mature and significant trees and landscapes. Some sites are located adjacent to the coastline and/or wetland areas.
	Approximately 1,299 ac (526 ha)	Navy	Family Housing Communities: (1) Catlin Park; (2) Doris Miller Park; 3) Ford Island; (4) Halawa; (5) Hale Alii; (6) Hale Moku; (7) Halsey Terrace; (8) Hokulani; (9) Hospital Point; (10) Little Makalapa; (11) Makalapa; (12) Maloelap; (13) Mānana; (14) Marine Barracks; (15) McGrew Point; (16) Moanalua Terrace; (17) Pearl City Peninsula; (18) Radford Terrace; and (19) Red Hill (as shown on Figure 3-7).	Yes, contains mature and significant trees and landscapes. Some sites are located adjacent to the coastline and/or wetland areas.
Total PHNC	Approximately 78,315 ac (37,566 ha)			
Lualualei	Approximately 7,498 ac (3,034 ha)	Navy	Operational Areas of NAVMAG PH Lualualei Branch: (1) extensive munitions magazine complex; (2) warehousing; (3) operating buildings; (4) community and personnel support facilities; and (5) a considerable amount of open space within the ESQD arcs.	Yes, includes federally-listed plants and bird species; critical habitat; MBTA-protected birds; wetland areas including a wildlife refuge.
	Approximately 1,700 ac (687 ha)	Navy	Operational Areas of NRTF Lualualei: Used to transmit state-of-the-art high and low frequency radio signals for the navigation of Navy vessels throughout the Pacific; signals create high-density electromagnetic radiation (EMR) hazards; EMR zones are designated around transmitter sites.	Yes, federally-listed plants and bird species and MBTA-protected birds, includes a wetland/wildlife refuge, and agricultural outleases.

Table ES-1: Lands and Waters Owned, Leased, or Controlled by JBPHH (Continued)

INRMP Study Area	Approximate Land Area in ac (ha)	Land Ownership	Land Use and Types of Operations	Requires a Natural Resources Management Plan
Total Lualualei	9,198 ac (3,722 ha)			
NCTAMSPAC	700 ac (283 ha)	Navy	Operational Areas of NCTAMSPAC Wahiawa: Contains operations, open space around antennas, and family housing and community support facilities.	Yes, mature and significant trees and landscapes, MBTA-protected birds, and native mesic forest.
	40 ac (16 ha)	Navy	Family Housing Communities: Camp Stover.	Yes, mature and significant trees.
Total NCTAMSPAC Wahiawa	740 ac (299 ha)			
Kalaeloa	2,054 ac (831 ha) land	Navy	Areas with Significant Natural Resources: (1) NAVFAC Hawaii Biosolids Treatment Facility; (2) Morale, Welfare, and Recreation (MWR) Barbers Point Golf Course and Stables; (3) MWR Nimitz Beach; and (4) MWR White Plains Beach; (5) Lot 58-D; (6) Lot 58-F; (7) Lot 73-A; and (8) Lot 74-D. Highly Developed and Industrialized Areas: (1) Defense Reutilization and Marketing Offices (DRMO) office and warehouse space; (2) NAVFAC HI West O'ahu Shop; (3) Lot 58-B; and (4) Lot 58-G.	Yes. Sensitive habitats, outdoor recreational facilities.
Hickam	2,669 ac (1,080 ha)	USAF	Operational areas of Hickam and Hickam POL Pipeline : Land use categories include housing, community service, medical, outdoor recreation, open space/roads, light industrial, aircraft operations and maintenance, airfield, and open water.	Yes, includes federally-listed bird species and sea turtles; MBTA-protected birds; marine mammals may occur in adjacent coastal waters; includes wetlands; and outdoor recreation areas.
Total JBPHH	Total: approximately 92,976 ac (37,626 ha); Land: approximately 24,895 ac (10,075 ha); Water: approximately 68,081 ac (27,552 ha) water			

2. PROTECTED SPECIES AND HABITATS

Chapters 3 through 7 detail the locations, military activities, resources and current management actions and policies for the different areas: (1) PHNC; (2) the Lualualei INRMP Study Area (NAVMAG PH Lualualei and NRTF Lualualei); (3) the NCTAMSPAC Wahiawa INRMP Study Area (including Camp Stover); (4) Navy-retained at Kalaeloa; and (5) Hickam (Figure ES-1 and Table ES-1). Each area has unique natural resources and operational activities; therefore, management goals and objectives are detailed separately for each site. The following paragraphs provide a summary of the protected species found at JBPHH. Table ES-6 provides the INRMP 10-Year Fiscal Plan for these facilities.

PHNC

Table ES-2 provides a listing of the federally-listed Endangered Species Act (ESA) and State of Hawaii (SOH)-listed species, and petitioned species that occur at PHNC.

Table ES-2: Federally-Listed ESA Species, SOH-Listed Species, and Petitioned Species at PHNC

Latin Binomial	Common Name	Regulatory Status
Anas wyvilliana	Hawaiian Duck (Koloa)	E
Gallinula chloropus sandviciensis	Hawaiian Common Moorhen	E
Fulica alai	Hawaiian Coot	E
Himantopus mexicanus knudseni	Hawaiian Stilt	E
Gygis alba	White Tern	E (SOH only)
Asio flammeus sandwichensis	Hawaiian Short-eared Owl	E (SOH only)
Monachus schauinslandi	Hawaiian Monk Seal	E (proposed CH)
Megaptera novaeangliae	Humpback Whale	E
Eretmochelys imbricata	Hawksbill Sea Turtle	E
Chelonia mydas	Green Sea Turtle	T
Cyphastrea agassizi	Agassiz's coral	Petitioned
Cyphastrea ocellina	Ocellated coral	Petitioned
Leptoseris incrustans	Porcelain coral	Petitioned
Montipora dilatata	Hawaiian reef coral	Petitioned
Montipora flabellata	Blue rice coral	Petitioned
Montipora patula	Spreading coral	Petitioned
Porites pukoensis	No common name	Petitioned
Psammocora stellata	No common name	Petitioned

E – endangered; T – threatened; SOH – State of Hawaii; CH- critical habitat

Within Pearl Harbor there are federally- and SOH-listed birds, sea turtles, and marine mammals. All federally-listed species are also SOH-listed species. Critical habitat has not been declared within PHNC for any of these species. In addition, the USFWS maintains the Waiawa and

Honouliuli Units of Pearl Harbor National Wildlife Refuge (PHNWR) which provide habitat for protected bird species.

Bird Species: There are four federally-listed endangered bird species found at PHNC: (1) Hawaiian duck; (2) Hawaiian common moorhen; (3) Hawaiian coot; and (4) Hawaiian black-necked stilt. There are two SOH-listed endangered endemic birds: (1) the white (fairy) tern; and (2) the Hawaiian short-eared owl.

There are numerous migratory bird species protected under the Migratory Bird Treaty Act of 1918 (MBTA) present at PHNC. The majority of these bird species are present at the Honouliuli and Waiawa Units of the Pearl Harbor National Wildlife Refuge (NAVFAC PAC 2006a).

Marine Mammals: There are two federally-listed marine mammals found in Hawaiian waters at PHNC: (1) the endangered Hawaiian monk seal; and (2) the endangered humpback whale.

Reptilian Species: There are two federally-protected marine reptiles (sea turtles) at PHNC. All sea turtles are protected under the federal ESA. The threatened green turtle is actually quite common in the Hawaiian Islands and is observed at Pearl Harbor. The endangered hawksbill turtle is considered rare compared to the threatened green turtle.

Protected Plants: There are no federally- or SOH-listed plant species that occur naturally in the PHNC. The USFWS and DLNR are currently raising federal- and SOH-listed endangered plants (*Pritchardia remota, Sesbania tomentosa, Abutilon menziesii*) at PHNWR Honouliuli Unit. These plants are not further discussed as part of natural resources for PHNC.

Lualualei

Table ES-3 provides a listing of the federally-listed ESA and SOH-listed species, and species of concern that occur at the Lualualei INRMP Study Area.

Table ES-3: Federally- and SOH-Listed ESA Species, Candidate Species, and Species of Concern at Lualualei

Latin Binomial	Common Name	Regulatory Status
Animal Species		
Bird Species		
Anas wyvilliana	Hawaiian Duck (Koloa)	E
Gallinula chloropus sandviciensis	Hawaiian Common Moorhen	E
Himantopus mexicanus knudseni	Hawaiian Stilt	E
Fulica alai	Hawaiian Coot	E
Chasiempis sandwichensis ibidis	O'ahu 'Elepaio	E, last observed 2008, CH
Asio flammeus sandwichensis	Hawaiian Short-eared Owl	E (SOH only)
Mammal Species		
Lasiurus cinereus semotus	Hawaiian Hoary Bat	E, probable
Snail Species		
Achatinella mustelina	O'ahu Tree Snail	E
Amastra cyclindrica	NCN	None, but critically rare, potential for listing

Table ES-3: Federally- and SOH-Listed ESA Species, Candidate Species, and Species of Concern at Lualualei

Latin Binomial	Common Name	Regulatory Status
Arthropod Species		
Drosophila spp.	Hawaiian Picture Wing flies	Not listed, species observed, but discussion needed
Hylaeus spp.	Hawaiian Yellow-faced Bees	Not listed, species may be present, but discussion needed
Megalagrion spp	Hawaiian damselflies	Not listed, species observed, but discussion needed
Plant Species		
Abutilon menziesii	NCN	E, CH (no data on CH acreage)
Abutilon sandwicense	NCN	E, CH (81 ac/33 ha CH)
Alectryon micrococcus	Mahoe	E, last observed 2004
Bobea sandwicensis	Ahakea	SOC
Bonamia menziesii	NCN	E
Chamaesyce kuwaleana	'Akoko	E, CH (268 ac/108 ha CH)
Cyanea calycina	Haha	Candidate
Cyperus trachysanthos	NCN	E, CH (no data on CH acreage)
Diellia falcata	NCN	E, unoccupied CH (97 ac/39 ha CH)
Diellia unisora	NCN	E, CH (278 ac/113 ha CH)
Flueggea neowawraea	Mehamehame	E
Gouania meyenii	NCN	E, unoccupied CH (7 ac/3 ha CH)
Kadua (was Hedyotis) parvula	NCN	E, CH (325 ac/132 ha CH)
Labordia kaalae	NCN	SOC
Lepidium arbuscula	NCN	E, CH (515 ac/208 ha CH)
Lipochaeta lobata var. leptophylla	Nehe	E, CH (1,194 ac/483 ha CH)
Lobelia niihauensis	NCN	E
Lobelia yuccoides	NCN	SOC
Marsilea villosa Kaulf.	Ihiihi	E, CH (169 ac/68 ha CH)
Melanthera tenuis	NCN	SOC
Melicope christophersenii	Aani	Candidate
Melicope pallida	Alani	E, unoccupied CH (122 ac/49 ha CH)
Melicope saint-johnii	Alani	E, unoccupied CH (169 ac/68 ha CH)
Neraudia angulata var. angulata	NCN	E, CH (207 ac/84 ha CH)
Neraudia angulata var. dentate	NCN	E, CH
Neraudia melastomifolia	NCN	SOC
Nototrichium humile	Kului	E
Plantago princeps var. princeps	Laukahi Kuahiwi	E
Platydesma cornuta var. decurrens	NCN	Candidate
Pleomele forbesii	Hala Pepe	Candidate
Sanicula mariversa	NCN	E, unoccupied CH (81 ac/33 ha CH)
Schiedea hookeri	NCN	E, CH (238 ac/96 ha CH)
Schiedea pentandra	NCN	SOC
Silene perlmanii	NCN	E, unoccupied CH (285 ac/115 ha CH)
Spermolepis hawaiiensis	NCN	E
Tetramolopium filiforme Sherff	NCN	E
Tetramalopium lepidotum ssp. lepidotum	NCN	E, unoccupied CH

Table ES-3: Federally- and SOH-Listed ESA Species, Candidate Species, and Species of Concern at Lualualei

Latin Binomial	Common Name	Regulatory Status
Urera kaalae	NCN	E. unoccupied CH
Viola chamissoniana ssp. chamissoniana	Pamakani	E, CH

NCN – no common name, E=endangered; SOH=State of Hawaii; CH=critical habitat; SOC = species of concern

Protected Animals. Two federally-listed endangered, endemic (i.e., found nowhere else in the world) animal species and one SOH-listed endangered, endemic species inhabit NAVMAG PH Lualualei Branch: (1) O'ahu tree snail (*Achatinella mustelina*); (2) O'ahu 'elepaio (*Chasiempis sandwichensis ibidis*); and (3) Hawaiian short-eared owl (HNHP 2004a). In addition, the very rare snail, *Amastra cylindrica*, was found within the installation. Also, the federally-listed Hawaiian hoary bat (*Lasiurus cinereus semotus*) probably occurs at NAVMAG PH Lualualei.

Four federally-listed endangered, endemic waterbird species occur within the Niuli'i Ponds on NRTF Lualualei: (1) Hawaiian black-necked stilt; (2) Hawaiian common moorhen; (3) Hawaiian coot; and (4) Hawaiian duck. However, the ducks identified as Hawaiian ducks are probably hybrid mallard-Hawaiian ducks. One SOH-listed endangered (on O'ahu), the Hawaiian short-eared owl, may occur at NRTF Lualualei (HNHP 2004b). Hawaiian hoary bats probably occur at NRTF Lualualei.

Protected Plants. There are 21 federally-listed endangered plant species, two federal candidate species, and six federal species of concern that occur at the Lualualei INRMP Study Area. Critical habitat has been designated for 21 plant species within the Lualualei INRMP Study Area. Thirteen of those plant species have been recorded in the study area: (1) *Abutilon menziesii*; (2) *Abutilon sandwicense*; (3) *Chamaesyce kuwaleana*; (4) *Cypersus trachysanthos*; (5) *Diellia unisora*; (6), *Hedyotis parvula*; (7) *Lepidium arbuscula* ; (8) *Lipochaeta lobata var. leptophylla*; (9) *Marsilea villosa*; (10) *Neraudia angulata var. angulata*; (11) *Neraudia angulata var. dentate*; (12) *Schiedea hookeri*; (13) *Viola chamissoniana* ssp. *chamissonian*. The remaining eight species have not been recorded in the study area and are considered unoccupied portions of critical habitat: (1) *Diellia falcata*; (2) *Gouania meyenii*; (3) *Melicope saint-johnii*; (4) *Melicope pallida*; (5) *Sanicula mariversa*; (6) *Silene perlmanii*; (7) *Tetramolopium lepidotum* ssp. *Lepidotum*; and (8) *Urera kaalae.*

NCTAMSPAC

One SOH-listed (only on O'ahu) endangered bird species, the Hawaiian short-eared owl, may be present at the NCTAMSPAC Wahiawa. The endemic Hawaiian short-eared owl may utilize the wooded gulches and open grass habitat, but none were observed during intensive field surveys at the station in 1986. The federally-listed endangered Hawaiian hoary bat may occur at NCTAMSPAC Wahiawa. There are no federally- or SOH-listed plant species at NCTAMSPAC Wahiawa (HNHP 2004b). There are no critical habitats, natural resource research areas, or ecological reserves at NCTAMSPAC Wahiawa.

There are no federally- or SOH-listed threatened or endangered animal or plant species known to occur at the Camp Stover Housing Community. There are no critical habitats, natural resource research areas, or ecological reserves at the Camp Stover Housing Community.

Navy-Retained Land at Kalaeloa

Table ES-4 provides a listing of the federally-listed ESA species and species of concern that occur at Kalaeloa.

Table ES-4: Federally-Listed ESA Species and Species of Concern at Kalaeloa

Latin Binomial	Common Name	Regulatory Status
Himantopus mexicanus knudseni	Hawaiian Black-necked Stilt	E
Monachus schauinslandi	Hawaiian Monk Seal	E (proposed CH)
Chamaesyce kuwaleana	'Akoko	E
Achyranthes splendes *var.* rotundata	Round-leafed chaff-flower shrub	E (not on Navy-retained lands)
Capparis sandwichiana *var.* zoharyi	Pua pio	SOC (not on Navy-retained lands)

E – endangered; T – threatened; CH- critical habitat; SOC – Species of Concern

Protected Animals. One federally-listed endangered waterbird, the Hawaiian black-necked stilt has been reported at the Biosolids Treatment Facility, the Barbers Point Golf Course and Stables (NAVFAC Pacific 2006a), Lot 13058-F, and Lot 13073-A (DON 2011a). Five MBTA-protected bird species (cattle egret [*Bubulcus ibis*], black-crowned night heron [*Nycticorax nycticorax*], Pacific golden plover [*Pluvialis fulva*], ruddy turnstone [*Arenaria interpres*], wandering tattler [*Heteroscelus incanus*]) have been reported at Navy-retained lands at Kalaeloa.

Protected Plants. Two federally-listed endangered plant species occur within the Kalaeloa District: (1) 'Ewa Plain 'akoko shrub (*Chamaesyce skottsbergii* var.*kalaeloana*); and (2) the round-leafed chaff-flower shrub (*Achyranthes splendes* var. *rotundata*). The 'akoko shrub occurs within Lot 13058-D. The round-leafed chaff flower shrub occurs outside of the Navy-retained lands at Kalaeloa. Pua pio (*Capparis sandwichiana* var. *zoharyi*), an endemic shrub that is a (federal) species of concern, has been documented along the southern boundary of the Kalaeloa District but not within the Navy-retained lands.

Hickam and Hickam Petroleum Oil Lubricant (POL) Pipeline

Table ES-5 provides a listing of the federally- and state-listed threatened and endangered species that occur at Hickam and Hickam POL Pipeline.

Table ES-5: Federally- and SOH-Listed ESA Species at Hickam and Hickam POL Pipeline

Latin Binomial	Common Name	Regulatory Status
Himantopus mexicanus knudseni	Hawaiian black-necked stilt	E
Anas wyvilliana	Hawaiian duck	E (potentially occurring)
Fulica alai	Hawaiian coot	E (potentially occurring)
Gallinula chloropus sandviciensis	Hawaiian moorhen	E (potentially occuring)
Asio flammeus sandwichensis	Hawaiian short-eared owl	E (SOH only)
Monachus schauinslandi	Hawaiian monk seal	E
Lasiurus cinereus semotus	Hawaiian hoary bat	E (potentially occurring)
Chelonia mydas	Green turtle	T

E – endangered; T – threatened;

Protected Animals. One federally-listed endangered waterbird, the Hawaiian black-necked stilt, is common in coastal wetland areas at Hickam. Hawaiian Duck X mallard hybrids, and potentially Hawaiian ducks, are also frequently observed in ponding areas around base. The other two listed waterbirds potentially occur on base. Hawaiian Monk Seals are occasionally observed at Hickam beaches, and injured green turtles occasionally wash up on shore. Six MBTA-protected bird species (cattle egret [*Bubulcus ibis*], black-crowned night heron [*Nycticorax nycticorax*], Pacific golden plover [*Pluvialis fulva*], ruddy turnstone [*Arenaria interpres*], wandering tattler [*Heteroscelus incanus*]) and sanderling [*Calidris alba*]) are common at Hickam. The Hawaiian hoary bat potentially occurs at Hickam POL pipeline.

3. CONTINUING AND PROPOSED NATURAL RESOURCES PROGRAM ELEMENTS

Table ES-6 provides the INRMP Ten Year Fiscal Plan which includes recommended projects for JBPHH. The plan includes the estimated costs for each project, funding priority and class (Chapter 9), and implementation schedule.

Table ES-6: INRMP Ten-Year Fiscal Plan

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
A. PHNC Recommended Management Actions														Section 9.3.1
1. Regulatory agency coordination	PSEMM	P2/NOC	Costs included under normal operating costs											
2. Protected bird species management, monitoring and reporting	PSEMM	P2/C2	$8,000	$8,000	$9,000	$9,000	$10,000	$10,000	$10,000	$11,000	$11,000	$12,000	$98,000	Costs also cover B2, C2, D2, and E2
3.Hawaiian waterbird banding and resighting study	PSEMM	P2/C2	$0	$28,000	$0	$0	$0	$30,000	$0	$0	$0	$33,000	$91,000	Costs also cover B3, and E4
4. Hawaiian bat acoustic surveys	PSEMM	P2/C2	$15,000	$16,000	$16,000	$17,000	$18,000	$19,000	$20,000	$20,000	$21,000	$22,000	$184,000	Costs also cover B6 and C3
5. Hawaiian monk seal monitoring and protection	PSEMM	P2/NOC/ C2	Costs included under normal operating costs, A6, A7, A8, A9, A10, and A12											
6. Maintain/update Standard Operating Procedures (SOPs) for protection of ESA-protected species	PSEMM	P2/C2	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$3,000	$3,000	$3,000	$3,000	$24,000	Costs also cover B4, D4, and E6
7. Management actions for rare and protected species during training activities	PSEMM	P2/NOC/ C2	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$30,000	Costs also cover D5
8. Marine debris reduction	PSEMM	P2/NOC/ C2	$3,000	$3,000	$3,000	$3,000	$4,000	$4,000	$4,000	$4,000	$4,000	$4,000	$36,000	Costs also cover D6, and E8
9. Provide staff-focused, annual natural resources training	PSEMM (natural resources awareness)	P2/C2	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$3,000	$3,000	$3,000	$3,000	$24,000	Costs also cover B14, C4, D8, and E7
10. Maintain security restrictions	PSEMM (access restrictions)	P2/NOC/ C2	Costs included under normal operating costs, A55											
11. Conserve Waiawa Watershed as a natural area	PSEMM (access restrictions)	P2/NOC	Costs included under normal operating costs.											
12. Predator control at PHNC	PSEMM (invasive species)	P2/C2	$70,000	$73,000	$76,000	$80,000	$83,000	$87,000	$91,000	$95,000	$100,000	$104,000	$859,000	Costs also cover B16, D11, E10
13. Pearl Harbor biosecurity plan	PSEMM (invasive species)	P2/C2	$0	$0	$120,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$190,000	Formal plan to be developed in fy14. Plan will be implemented in out years. Costs also cover E12

Table ES-6: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
14. Invasive species biosecurity SOPs	PSEMM (invasive species)/ Community Outreach	P2/C2	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$3,000	$3,000	$3,000	$3,000	$24,000	Costs also cover B17, C7, D12, E13
15. Control alien plants	PSEMM (invasive species)	P2/C2	$12,000	$13,000	$13,000	$14,000	$14,000	$15,000	$16,000	16,000	$17,000	$18,000	$149,000	Costs also cover B18, C8, D13, and E14
16. Mangrove and pickleweed removal in Pearl Harbor	PSEMM (invasive species and wetlands)	P2/C2	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$800,000	Costs also cover E9
17. Reduce and prevent the release of Aquatic Invasive Species (AIS)	PSEMM (invasive species)	P2/NOC/ C2	$5,000	$0	$30,000	$0	$0	$0	$0	$0	$0	$0	$35,000	Costs include initial comp water sampling in fy12 and a comp water management plan developed in fy14.
18. Bilge and ballast purge	PSEMM (invasive species)	P2/NOC	Costs included under normal operating costs.											
19. Invasive algae control and early detection of incipient marine invasive species	PSEMM (invasive species)	P2/C2	$5,000	$5,000	$5,000	$56,000	$6,000	$6,000	$7,000	$7,000	$7,000	$7,000	$111,000	Costs include Gracilaria control in 2015 and annually recurring monitoring form incipient marine invasive species
20. Early detection roadside surveys	PSEMM (invasive species)	P2/C2	$5,000	$5,000	$5,000	$6,000	$6,000	$6,000	$7,000	$7,000	$7,000	$7,000	$61,000	Costs also cover B26, C9, D14, and E15
21. Revegetation with native plants	PSEMM (natural resources restoration)	P2/C2	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$100,000	Costs, also cover B27, C10, D15, and E16
22. Pearl Harbor wetland and riparian ecosystem restoration plan	PSEMM (natural resources restoration /wetlands)	P2/C2	$0	$0	$0	$0	$150,000	$0	$0	$0	$0	$0	$150,000	
23. Wetlands management	PSEMM (wetlands)	P2/NOC	Costs included under normal operating costs and A22											

Table ES-6: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
24. Update wetlands survey	PSEMM (wetlands)	P2/C2	$0	$0	$0	$0	$90,000	$0	$0	$0	$0	$90,000	$180,000	
25. INRMP annual and 5-year updates	Natural Resources Studies	P2/C2	$10,000	$10,000	$11,000	$80,000	$12,000	$12,000	$13,000	$13,000	$90,000	$14,000	$265,000	
26. Update/initiate installation-wide flora and fauna mapping	Natural Resources Studies	P2/C2	$0	$0	$0	$0	$75,000	$0	$0	$0	$0	$75,000	$150,000	Costs cover B31, C13, and D18
27. Update marine resources and fisheries survey	Natural Resources Studies	P2/C2	$26,000	$27,000	$28,000	$30,000	$31,000	$32,000	$34,000	$35,000	$37,000	$39,000	$319,000	
28. Study the effects of fishing on Pearl Harbor with a creel survey	Natural Resources Studies/ Outdoor Recreation	P3/C3	$0	$0	$18,000	$0	$0	$0	$0	$20,000	$0	$0	$38,000	
29. Coastal wetland and dryland restoration study	Natural Resources Studies	P3/C3	Alternate funding sources (e.g. Legacy)											
30. Feasibility study for aquatic invasive species control	Natural Resources Studies	P3/C3	$0	$0	$0	$0	$0	$0	$0	$20,000	$0	$0	$20,000	Pursue alternate funding sources
31. Natural resource Geographic Information System (GIS) data management	GIS	P2/C2	$3,000	$3,000	$3,000	$3,000	$35,000	$4,000	$4,000	$4,000	$4,000	$40,000	$103,000	Costs also cover B33, C14, D19, and E22
32. Develop a GIS layer for mature and significant trees and landscapes	GIS/Forestry	P3/C3	$0	$0	$0	$0	$0	$40,000	$0	$0	$0	$0	$40,000	Costs also cover B34, C15, D20, and E23
33. Protect mature and significant trees, landscapes, and pocket forests	Forestry	P2/NOC	Costs included under normal operating costs.											
34. Continue standard provisions in construction/landscape contracts	Forestry/ Land Management	P2/NOC	Costs included under normal operating costs.											
35. Promote awareness of ESA- and other protected species and natural resources stewardship	Community Outreach	P3/NOC	Costs included under normal operating costs through CNRH outreach coordinator											

Table ES-6: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
36. Support PHNWR Honouliuli and Waiawa Units	Community Outreach	P3/NOC	Costs included under normal operating costs											
37. Promote public education on hazards of fish consumption	Community Outreach	P3/NOC/ C3	Costs included under normal operating costs through CNRH outreach coordinator and encroachment coordinator, and through hiring of a conservation officer A54											
38. Support identification and mitigation of public health risks	Community Outreach	P3/NOC	Costs included under normal operating costs											
39. Water and sediment quality and public health	Community Outreach	P2/C2	Costs included under EV Compliance program											
40. Continue to support a public overlook at PHNWR Honouliuli Unit	Community Outreach	P3/NOC	Costs included under Regional Environmental Coordinator program											
41. Adopt a waterfront	Community Outreach	P3/NOC	Costs included under normal operating costs through CNRH outreach coordinator and encroachment coordinator											
42. Storm-water stenciling	Community Outreach	P3/C3	Costs included under EV compliance program											
43. Protect fishpond walls	Community Outreach	P2/C2/ NOC	Costs included under A16 and normal operating costs through the CNRH outreach coordinator											
44. Continue to support Rainbow Bay Marina	Outdoor Recreation	P3/NOC	Costs included under MWR program											
45. Continue recreational catch-and-release fishing and study the effects of fishing on the harbor	Outdoor Recreation	P3/NOC/ C3	Costs included under MWR program and A28											
46. Continue to support bicycling, jogging, and walking	Outdoor Recreation	P3/NOC	Costs included under MWR program											
47. Continue to promote public outdoor recreation events	Outdoor Recreation	P3/NOC	Costs included under MWR program											
48. Hunting ungulates for outdoor recreation	Outdoor Recreation/ Land Management	P3/C3	$12,000	$5,000	$5,000	$6,000	$6,000	$6,000	$7,000	$7,000	$7,000	$7,000	$68,000	Costs also cover B20 and C6. B20 is a P2/C2 project
49. Base planning	Land Management	P2/NOC	Costs included under normal operating costs.											
50. Landscape design	Land Management	P2/NOC	Costs included under normal operating costs.											
51. Prevention of point source pollution	Land Management	P2/NOC	Costs included under EV Compliance program											

Table ES-6: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
52. Soil stabilization and erosion control	Land Management	P2/NOC	Costs included under EV Compliance program											
53. Replant eroded landscapes	Land Management	P2/C2	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$15,000	
54. Land management restrictions during training maneuvers	Land Management	P2/NOC	Costs included under normal operating costs.											
55. Law enforcement	Law Enforcement	P2/NOC/ C2	$0	$0	$80,000	$84,000	$87,000	$91,000	$95,000	$100,000	$104,000	$109,000	$750,000	Costs include salary for Conservation Officer. Cost covers B45 , C24, D32 and E36
56. Maintain security fencing and firebreaks	Wildland Fire	P2/NOC	Costs included under normal operating costs.											
57. Emergency fire fighting by personnel during training exercises	Wildland Fire	P2/NOC	Costs included under normal operating costs.											
58. Monitor off-site development	Leases and Encroach-ment Management	P2/NOC	Costs included under normal operating costs under CNRH Encroachment coordinator											
59. Agricultural outleases	Leases and Encroach-ment Management	P3/C3	$0	$0	$0	$0	$0	$0	$0	$65,000	$0	$0	$65,000	Costs also cover B45
B. Lualualei Recommended Management Actions														Section 9.3.2
1. Regulatory agency coordination	PSEMM	P2/NOC	Costs included under normal operating costs.											
2. Protected bird species management, monitoring and reporting	PSEMM	P2/C2	Costs included in A2											
3. Hawaiian waterbird banding and resighting study	PSEMM	P2/C2	Costs included in A3											
4. Maintain/update SOPs for protection of ESA-protected species	PSEMM	P2/NOC	Costs included in A6											
5. O'ahu 'elepaio monitoring and management	PSEMM	P2/C2	$4000	$4,000	$4,000	$5,000	$5,000	$5,000	$5,000	$5,000	$6,000	$6,000	$49,000	

Table ES-6: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
6. Hawaiian bat acoustic surveys	PSEMM	P2/C2	Costs included in A4											
7. NAVMAG Lualualei Hawaiian picture wing fly and arthropod surveys	PSEMM	P2/C2	$25,000	$26,000	$27,000	$29,000	$30,000	$31,000	$33,000	$34,000	$36,000	$37,000	$308,000	
8. NAVMAG Lualualei stream bioassessments	PSEMM	P2/C2	$5,000	$5,000	$5,000	$6,000	$6,000	$6,000	$7,000	$7,000	$7,000	$7,000	$61,000	
9. Amastra cylindrical management	PSEMM	P2/C2	$30,000	$31,000	$33,000	$34,000	$36,000	$37,000	$39,000	$41,000	$43,000	$45,000	$369,000	
10. Achatinella mustelina management	PSEMM	P2/C2	$8,000	$8,000	$9,000	$9,000	$10,000	$10,000	$10,000	$11,000	$11,000	$12,000	$98,000	
11. Monitoring and management of NAVMAG PH Lualualei Branch listed/candidate/species of concern plant species	PSEMM	P2/C2	$45,000	$47,000	$49,000	$51,000	$54,000	$56,000	$59,000	$61,000	$64,000	$67,000	$533,000	
12. Fencing and signage used to mark presence of rare and/or protected species	PSEMM	N2/C2	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$25,000	Costs also cover D9
13. Abutilon menziesii, Marsilea villosa, Cyperus trachysanthos monitoring and management	PSEMM	P2/C2	$7,500	$3,500	$3,500	$3,500	$3,500	$3,500	$4,000	$4,000	$4,000	$4,000	$41,000	
14. Provide staff-focused, annual natural resources training	PSEMM (natural resources awareness)	P2/C2	Costs are included under A9											
15. Maintain security restrictions	PSEMM (access restrictions)	P2/NOC	Costs included under normal operating costs, A55.											
16. Predator control at Niuli'i Ponds	PSEMM (invasive species)	P2/C2	Costs are included under A12											
17. Invasive species biosecurity SOPs	PSEMM (Invasive Species)	P2/NOC	Costs included under A14											
18. Control alien plants	PSEMM (invasive species)	P2/C2	Costs included under A15											

Table ES-6: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
19. Monitor, control and exclude feral ungulates within Special Management Areas (SMAs)	PSEMM (invasive species)	P2/C2	$12,000	$13,000	$400,000	$20,000	$400,000	$25,000	$400,000	$30,000	$400,000	$50,000	$1,750,000	
20. Hunting to control feral ungulates	PSEMM (invasive species)	P2/C2	Costs included under A48											
21. *Euglandina* control techniques	PSEMM (invasive species)	P2/C2	$0	$0	$30,000	$30,000	$0	$0	$0	$0	$0	$0	$60,000	
22. Chameleon detection and control	PSEMM (invasive species)	P2/C2	$0	$0	$0	$0	$30,000	$30,000	$0	$0	$0	$0	$60,000	
23. Native habitat management through invasive vegetation removal at SMAs in NAVMAG Lualualei	PSEMM (invasive species)	P2/C2	$80,000	$84,000	$87,000	$91,000	$95,000	$100,000	$104,000	$109,000	$114,000	$119,000	$983,000	
24. Black-stem borer research	PSEMM (invasive species)	P2/C2	$0	$0	$0	$0	$0	$0	$30,000	$30,000	$0	$0	$60,000	
25. Peafowl seed predation study	PSEMM (invasive species)	P2/C2	$0	$0	$0	$0	$0	$0	$0	$0	$15,000	$0	$15,000	
26. Early detection roadside surveys	PSEMM (invasive species)	P2/C2	Costs are included under A20											
27. Revegetation with native plants	PSEMM (natural resources restoration)/Land Management	P2/C2	Costs are included under A21											
28. Wetlands management	PSEMM (wetlands)	P2/NOC	Costs included under normal operating costs.											
29. Maintain Niuli'i Ponds as waterbird habitat	PSEMM (wetlands)	P2/C2	$7,000	$7,000	$8,000	$8,000	$8,000	$9,000	$9,000	$10,000	$10,000	$10,000	$86,000	.
30. INRMP annual and 5-year updates	Natural Resources Studies	P2/C2	Costs are included under A25											

Table ES-6: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
31. Update/initiate installation-wide flora and fauna mapping	Natural Resources Studies	P2/C2	Costs are included under A26											
32. Dryland forest restoration studies	Natural Resources Studies	P3/C3	Alternate funding sources (e.g. Legacy)											
33. Natural resources GIS data management	GIS	P2/C2	Costs included under A31											
34. Develop a GIS layer for mature and significant trees and landscapes	GIS	P3/C3	Costs included under A32											
35. Protect mature and significant trees, landscapes, and pocket forests	Forestry	P2/NOC	Costs included under normal operating costs.											
36. Continue standard provisions in construction/landscape contracts	Forestry/ Land Management	P2/NOC	Costs included under normal operating costs.											
37. Promote awareness of ESA- and other protected species and natural resources stewardship	Community Outreach	P3/NOC	Costs included under normal operating costs through CNRH outreach coordinator											
38. Base planning	Land Management	P2/NOC	Costs included under normal operating costs.											
39. Landscape design	Land Management	P2/NOC	Costs included under normal operating costs.											
40. Prevention of point source pollution	Land Management	P2/NOC	Costs included under normal operating costs.											
41. Soil stabilization and erosion control	Land Management	P2/NOC	Costs included under normal operating costs.											
42. Law enforcement	Law Enforcement	P2/NOC/ C2	Costs included under A54											
43. Continue FFD and/or Honolulu Fire Department (HFD) response to any wildland fires	Wildland Fire	P2/NOC/ C2	$0	$0	$65,000	$0	$0	$5,000	$0	$0	$5,000	$0	$75,000	Plan development in 2014; 3-year reviews.
44. Monitor off-site development	Wildland Fire	P2/NOC	Costs included under normal operating costs through CNRH encroachment coordinator.											

Table ES-6: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
45. Agricultural outleases	Leases and Encroach-ment Management	P2/NOC	Costs included under A58.											
C. NCTAMSPAC Wahiawa Recommended Management Actions														Section 9.3.3
1. Regulatory agency coordination	PSEMM	P2/ NOC	Costs included under normal operating costs											
2. Protected bird species management, monitoring and reporting	PSEMM	P2/C2	Costs included under A2											
3. Hawaiian bat acoustic surveys	PSEMM	P2/C2	Costs included under A4.											
4. Provide staff-focused, annual natural resources training	PSEMM (natural resources awareness)	P2/C2	Costs are included under A9											
5. Maintain security restrictions	PSEMM (access restrictions)	P2/NOC	Costs included under normal operating costs, A54.											
6. Hunting to control feral ungulates	PSEMM (invasive species)	P2/C2	Costs are included under A47											
7. Invasive species biosecurity SOPs	PSEMM (invasive species)	P2/C2	Costs are included under A14											
8. Control alien plants	PSEMM (invasive species)/ Land Management	P2/C2	Costs are included under A15											
9. Early detection roadside surveys	PSEMM (invasive species)	P2/C2	Costs are included under A20											
10. Revegetation with native plants	PSEMM (natural resource restoration)	P2/C2	Costs are included under A21											
11. Wetlands management	PSEMM (wetlands)	P2/NOC	Costs included under normal operating costs.											
12. INRMP annual and 5-year updates	Natural Resources Studies	P2/C2	Costs are included under A25											

Table ES-6: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
13. Update/initiate flora and fauna mapping	Natural Resources Studies	P2/C2	Costs are included under A26											
14. Natural resource GIS data management	GIS	P2/C2	Costs are included under A31											
15. Develop a GIS layer for mature and significant trees and landscapes	GIS/Forestry	P3/C3	Costs are included under A32											
16. Protect mature and significant trees, landscapes, and pocket forests	Forestry /Land Management	P2/NOC	Costs included under normal operating costs.											
17. Continue standard provisions in construction/landscape contracts	Forestry/ Land Management	P2/NOC	Costs included under normal operating costs.											
18. Promote awareness of ESA- and other protected species and natural resources stewardship	Community Outreach	P3/C3	Costs included under normal operating costs through the CNRH outreach coordinator											
19. Continue to support jogging, walking, hiking	Outdoor Recreation	P3/C3	Costs included under normal operating costs											
20. Base planning	Land Management	P2/NOC	Costs included under normal operating costs.											
21. Landscape design	Land Management	P2/NOC	Costs included under normal operating costs.											
22. Prevention of point source pollution	Land Management	P2/NOC	Costs included under normal operating costs through EV Compliance program											
23. Soil stabilization and erosion control	Land Management	P2/NOC	Costs included under normal operating costs.											
24. Law enforcement	Law Enforcement	P2/NOC/ C2	Costs included under A55.											
25. Continue FFD and/or HFD response to any wildland fires	Wildland Fire	P2/NOC	Costs included under normal operating costs.											
26. Monitor off-site development	Leases and Encroach-ment Management	P2/NOC	Costs included under normal operating costs.											

Table ES-6: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
D. Kalaeloa Recommended Management Actions														Section 9.3.4
1. Regulatory agency coordination	PSEMM	P2/NOC	Costs included under normal operating costs.											
2. Protected bird species management, monitoring and reporting	PSEMM	P2/C2	Costs included under A2											
3. Hawaiian monk seal protection	PSEMM	P2/NOC/ C2	Costs included under normal operating costs, A6, A7, A8, A9, A10, and A12											
4. Maintain/update SOPs for the protection of ESA-protected species	PSEMM	P2/C2	Costs are included under A6											
5. Protection of rare and/or protected species during training:	PSEMM	P2/NOC	Costs included under A7											
6. Marine debris reduction:	PSEMM	P2/NOC	Costs included under A8											
7. Kalaeloa 'akoko management	PSEMM	P2/C2	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$3,000	$3,000	$3,000	$3,000	$24,000	
8. Provide staff-focused, annual natural resources training	PSEMM (natural resources awareness)	P2/C2	Costs included under A9											
9. Fencing and signage used to mark presence of rare and/or protected species	PSEMM (access restrictions)	P2/C2	Costs are included under B12											
10. Access restrictions	PSEMM (access restrictions)	P2/NOC	Costs included under normal operating costs, A55											
11. Predator control at Nimitz and White Plains beaches	PSEMM	P2/C2	Costs included in A12											
12. Invasive species biosecurity SOPs	PSEMM (invasive species)	P2/C2	Costs included under A14											
13. Control alien plants	PSEMM (invasive species)	P2/C2	Costs included under A15											
14. Early detection roadside surveys	PSEMM (invasive species)	P2/C2	Costs included under A20											

Table ES-6: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
15. Revegetation with native plants	PSEMM (natural resources restoration)	P2/C2	Costs included under A21											
16. Wetlands management	PSEMM (wetlands)	P2/NOC	Costs included under normal operating costs.											
17. INRMP annual and 5-year updates	Natural Resources Studies	P2/C2	Costs are included under A25											
18. Update/initiate flora and fauna mapping	Natural Resources Studies	P2/C2	Costs included under A26											
19. Natural resource GIS data management	GIS	P2/C2	Costs included under A31											
20. Develop a GIS layer for mature and significant trees and landscapes	GIS/Forestry	P3/C3	Costs included under A32											
21. Protect mature and significant trees, landscapes, and pocket forests	Forestry/ Land Management	P2/NOC	Costs included under normal operating costs.											
22. Continue standard provisions in construction/landscape contracts	Forestry/ Land Management	P2/NOC	Costs included under normal operating costs.											
23. Promote awareness of ESA- and other protected species and natural resources stewardship	Community Outreach	P3/C3	Costs included under normal operating costs through CNRH outreach coordinator											
24. Continue to promote public outdoor recreation events	Outdoor Recreation	P3/NOC	Costs included under normal operating costs											
25. Continue to promote swimming, surfing, body boarding, jogging, bicycling, and picnicking	Outdoor Recreation	P3//NOC	Costs included under normal operating costs											
26. Base planning	Land Management	P2/NOC	Costs included under normal operating costs											
27. Landscape design	Land Management	P2/NOC	Costs included under normal operating costs											

Table ES-6: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
28. Prevention of point source pollution	Land Management	P2/NOC	Costs included under normal operating costs.											
29. Soil stabilization and erosion control	Land Management	P2/NOC	Costs included under normal operating costs.											
30. Land management restrictions during training maneuvers	Land Management	P2/NOC	Costs included under normal operating costs.											
31. Floodplains	Floodplains	P2/NOC	Costs included under normal operating costs.											
32. Law enforcement	Law Enforcement	P2/NOC/ C2	Costs included under A55											
33. Continue FFD and/or HFD response to any wildland fires	Wildland Fire	P2/NOC	Costs included under normal operating costs.											
34. Emergency fire fighting by personnel during training exercises	Wildland Fire	P2/NOC	Costs included under normal operating costs.											
E. Hickam Recommended Management Actions														Section 9.3.5
1. Regulatory agency coordination	PSEMM	P2/NOC	Costs included under normal operating costs											
2. Protected bird species management, monitoring, and reporting	PSEMM	P2/C2	Costs included under A2											
3. BASH support for Hickam Airfield	PSEMM	P2/C2	$5,000	$5,000	$5,000	$6,000	$6,000	$6,000	$7,000	$7,000	$7,000	$7,000	$61,000	
4. Hawaiian waterbird banding and resighting study	PSEMM	P2/C2	Costs included under A3											
5. Hawaiian monk seal protection	PSEMM	P2/NOC/ C2	Costs included under normal operating costs, A6, A7, A8, A9, A10, and A12											
6. Maintain/update SOPs for the protection of MBTA and ESA-protected species	PSEMM	P2/C2	Costs included under A6											
7. Provide staff-focused, annual natural resources training	PSEMM (natural resources awareness)	P2/C2	Costs included under A9											

Table ES-6: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
8. Ahua Reef cleanup	PSEMM (natural resources restoration)	P2/C2	Costs included under A8											
9. Mangrove removal	PSEMM (invasive species)	P2/NC2	Costs included in A16											
10. Predator control	PSEMM (invasive species)	P2/C2	Costs included under A12											
11. Exotic fish eradication	PSEMM (invasive species)	P2/C2	$0	$0	$0	$0	$0	$45,000	$0	$0	$0	$0	$45,000	
12. Hickam biosecurity plan	PSEMM (invasive species)	P2/C2	Costs included under A12											
13. Invasive species biosecurity SOPs	PSEMM (invasive species)	P2/C2	Costs included under A14											
14. Control alien plants	PSEMM (invasive species)	P2/C2	Costs included under A15											
15. Early detection roadside surveys	PSEMM (invasive species)	P2/C2	Costs included under A20											
16. Revegetation with native plants	PSEMM (natural resources restoration)	P2/C2	Costs included under A21											
17. Permitting requirements for training and other activities in wetlands	PSEMM (wetlands)	P2/NOC	Costs included under normal operating costs											
18. Habitat enhancement at Hickam wetlands	PSEMM (wetlands)	P2/C2	$30,000	$31,000	$33,000	$34,000	$36,000	$5000	$5000	$5000	$6000	$6000	$191,000	
19. Watercourse sediment removal feasibility study	PSEMM (wetlands)	Other	Costs included under the IRP or facilities											
20. Wetlands management	PSEMM (wetlands)	P2/NOC	Costs included under normal operating costs											

Table ES-6: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
21. INRMP annual and 5-year updates	Natural Resources Studies	P2/C2	Costs are included under A25											
22. Natural resource GIS data management	GIS	P2/C2	Costs included under A31											
23. Develop a GIS layer for mature and significant trees and landscapes	GIS/Forestry	P3/C3	Costs included under A32											
24. Protect mature and significant trees, landscapes, and pocket forests	Forestry/ Land Management	P2/NOC	Costs included under normal operating costs.											
25. Urban tree inventory	Forestry	Other	Costs are included under the ground maintenance budget											
26. Continue standard provisions in construction/landscape contracts	Land Management	P2/NOC	Costs included under normal operating costs.											
27. Promote awareness of ESA- and other protected species and natural resources stewardship	Community Outreach	P3/NOC	Costs are included under the normal operating costs through the CNRH outreach coordinator											
28. Bird watching guide	Outdoor Recreation	P3/C3	$0	$0	$0	$0	$6,000	$0	$0	$0	$0	$0	$6,000	
29. Continue to promote public outdoor recreation events	Outdoor Recreation	P3/NOC	Costs included under normal operating costs											
30. Continue to promote swimming, surfing, body boarding, jogging, bicycling, and picnicking	Outdoor Recreation	P3/NOC	Costs included under normal operating costs											
31. Base planning	Land Management	P2/NOC	Costs included under normal operating costs.											
32. Landscape design	Land Management	P2/NOC	Costs included under normal operating costs.											
33. Prevention of point source pollution	Land Management	P2/NOC	Costs included under normal operating costs through EV Compliance program.											
34. Soil stabilization and erosion control	Land Management	P2/NOC	Costs included under normal operating costs.											

Table ES-6: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
35. Land management restrictions during training maneuvers	Land Management	P2/NOC	Costs included under normal operating costs.											
36. Law enforcement	Law Enforcement	P2/NOC/ C2	Costs included under A55.											
37. Continue FFD and/or HFD response to any wildland fires	Wildland Fire	P2/NOC	Costs included under normal operating costs.											
38. Emergency fire fighting by personnel during training exercises	Wildland Fire	P2/NOC	Costs included under normal operating costs.											

PSEMM – protected species and ecosystem management and monitoring

P2/NOC – Priority 2/Normal Operating Costs

P2/C2 - Priority 2/ Class 2 Funding

P3/C3 – Priority 3/Cass Funding

CHAPTER 1
OVERVIEW

CHAPTER ONE: OVERVIEW

This Integrated Natural Resources Management Plan (INRMP) has been developed for the United States (U.S.) Department of the Navy (Navy or DON), Commander, Navy Region Hawaii (CNRH) for Joint Base Pearl Harbor-Hickam (JBPHH) to meet the statutory requirements of the Sikes Act Improvement Amendments (SAIA) of 1997 (16 U.S. Code [U.S.C.] 670(a) *et sequitor* [seq.] Public Law [PL] 105-85). This INRMP is one of two INRMPs prepared for CNRH. The other INRMP covers the Navy's Pacific Missile Range Facility which includes the Navy's facilities on Kaua'i, Ni'ihau, Ka'ula Island, and Mauna Kapu on O'ahu. This document updates previous INRMPs or natural resource management plans for JBPHH lands.

Chapter 1 provides an overview of the purpose, applicable laws, and process of the INRMP. Chapter 2 presents a general installation description. Chapters 3, 4, 5, and 6 provide summaries of the current conditions and use and natural resource program elements at the various JBPHH locations including Pearl Harbor Naval Complex (PHNC), Naval Magazine Pearl Harbor (NAVMAG PH) Lualualei Branch and Naval Radio Transmitter Facility Lualualei (NRTF Lualualei), Naval Computer and Telecommunications Area Master Station Pacific (NCTAMSPAC) Wahiawa and Camp Stover Family Housing Community, and Kalaeloa, respectively.[1] Hickam Air Force Base (AFB), which came under Navy control as of October 1, 2010 as the result of the Joint-Basing process, is covered in the Integrated Natural Resources Management Plan 2008-2012 Update For Hickam Air Force Base (AFB), Bellows Air Force Station (AFS), Hickam Petroleum, Oil Lubricant (POL) Pipeline, Kaala AFS, and Kokee AFS (U.S. Department of the Air Force [USAF] 2007). The latter four sites were not transferred to the Navy and are now managed by the 18th Air Base Wing out of Kadena AFB (Bellows AFS) and the 611th Air Support Group out of Joint-base Elmendorf-Richardson (Hickam POL, Kaala, and Kokee). The relevant sections of the Hickam INRMP are inserted as Chapter 7. Chapter 8 includes an insert relating to coral species at PHNC. Chapter 9 provides an implementation plan for JBPHH's natural resources projects, including those for Hickam AFB. Chapter 10 provides a summary of the references and resources used to prepare the INRMP. Chapter 11 provides a listing of the preparers and contributors to the plan.

1.1 PURPOSE

The primary purpose of this INRMP is to integrate the shore facility requirements of JBPHH, in support of its military mission, with the management and conservation of natural resources. The INRMP establishes JBPHH's approach and guidelines, relative to natural resources. To accomplish this end, the plan summarizes the baseline information and ensures compliance with regulatory and planning processes, such as those required by the National Environmental Policy

[1] Place names for JBPHH INRMP are listed in a place name key at the beginning of this plan (see table of contents) which provides the official names for these land areas.

Act (NEPA), Endangered Species Act (ESA), Clean Water Act (CWA), and Department of Defense (DOD) and Navy policies and legal requirements regarding natural resource planning.

This INRMP is intended to be a technical document to be used in the preparation of JBPHH approvals, management actions, orders, instructions, guidelines, standard operating procedures (SOPs), and other planning documents. It provides technical guidance for the integration of natural resource issues into planning and decision-making processes. Field personnel are expected to operate under guidelines, plans, orders, or other approvals that have been developed using this INRMP; have environmental compliance review; and, where applicable, regulatory approvals. This INRMP does not dictate land use decisions but, rather, provides information relevant to support sound land use decisions and natural resource management.

1.2 SCOPE

Navy installations, including JBPHH, having control of land and water assets suitable for conservation and management of natural resources, are required to prepare and implement an INRMP and updates every five years. The INRMP and its updates are to include all elements of natural resource management applicable to the installation. The INRMP and its updates must address compliance with federal mandates protecting specific natural resources. This INRMP outlines conservation efforts at JBPHH and establishes procedures to ensure compliance with applicable environmental laws and regulations. This INRMP is a living document that is continually updated and revised in accordance with Navy policies (Section 1.7.1).

1.3 RESPONSIBILITIES

Environmental stewardship is the responsibility for managing and caring for natural resources to ensure that these resources are sustainably managed for current and future generations. Stewardship of the environment can include recycling, conservation, regeneration, and restoration. In addition, it is an ethic whereby natural resources managers and personnel participate in the careful and responsible management of air, land, water, and biodiversity to ensure healthy ecosystems for present and future generations. It is an ethic that embodies cooperative planning and management of environmental resources with agencies, community organizations, and others to actively engage in the prevention of loss of habitat and to facilitate habitat recovery in the interest of long-term stability.

Responsibility for the preparation and implementation of the INRMP rests primarily with the installation commanding officer. Naval Facilities Engineering Command (NAVFAC), Hawaii (NAVFAC HI) and NAVFAC Pacific (NAVFAC PAC) Natural Resources staff work together with Navy activities in an on-going effort to sustainably manage the natural resources at JBPHH. In addition, the Navy works with U.S. Fish and Wildlife Service (USFWS), National Oceanographic and Atmospheric Administration (NOAA) National Marine Fisheries Services (NOAA Fisheries), the U.S. Department of Agriculture (USDA), and State of Hawai'i (SOH) Department of Land and Natural Resources (DLNR) personnel to adaptively manage these resources and to comply with the pertinent laws, regulations, and guidance presented in Section 1.5.

The Installation Environmental Program Manager (IEPM) assures coordination among facilities planners, resource managers, federal, SOH, and City and County of Honolulu (CCH) officials. The JBPHH IEPM provides program oversight and project budget implementation schedules. The JBPHH IEPM is the point of contact to provide relevant information on issues with potential to

affect protected bird species, direct habitat loss due to clearance and construction, proximity to neighboring habitats, and sensitivity of bird species to disturbance. NAVFAC HI supports JBPHH with natural resources expertise and serves as the point of contact for natural resource issues.

The JBPHH IEPM works with NAVFAC HI and NAVFAC PAC Natural Resources staff, the NAVFAC HI Natural Resource Program Manager, and appropriate SOH and federal agencies when mitigation planning is required to reduce the severity or intensity of impacts from a proposed action. Mitigation planning can include: (1) avoiding the impact altogether by not taking certain actions or parts of action or by moving the project location; (2) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by monitoring, maintaining, and/or replacing equipment or structures so that future environmental degradation due to equipment or structural failure does not occur during the life of an action; and (5) compensating for the impact by replacing or providing substitute resources or environments.

1.4 MILITARY MISSION

1.4.1 Achieving No Net Loss to the Military Mission

INRMPs are principally intended to help the Installation Commander and natural resource managers manage natural resources more effectively to ensure that installation lands remain available and in good condition to support the military mission (i.e., provide for "no net loss in the capability of the military installation lands to support the military mission of the installation"). Through implementing effective planning and conservation measures, the INRMP also provides a guide for meeting natural resources and conservation compliance requirements.

Appropriate management objectives to protect mission capabilities of installation lands (from which annual projects are developed) should be clearly articulated in the planning process and should be high in INRMP resourcing priorities. The effectiveness of the INRMP in providing for "no net loss" is evaluated annually. Mission requirements and priorities identified in the INRMP are, where applicable, integrated in other environmental programs and policies. It is not the intent that natural resources are to be consumed by mission requirements, but rather sustained to support mission requirements. In order to achieve this, environmental programs and policies must have the goal of controlling environmental encroachment and preserving an unencumbered environment for the purpose of the mission.

1.4.2 Defining Impact to the Military Mission

Impacts to the military mission can be defined by a loss of or reduction in ability to use land areas and facilities required to meet the operational requirements of the installation. This could include loss in training areas, base support, airfield operations, infrastructure, and/or delays in the mission due to lack of permits or violations of pertinent laws, regulations, and/or requirements.

Natural resources are managed to support the military mission and to provide sustainable environments for training, education, and operations. Ecosystem management recognizes that people are an integral component of ecological systems, and it supports multiple-use of natural resources and sustainable development. Within the safety and operational constraints, the installations work to provide outdoor recreational opportunities. These outdoor recreational

opportunities are consistent with demand from installation personnel, residents, military retirees in nearby communities, and the general public.

1.5 AUTHORITY

The SAIA is the basis for the preparation of the INRMP. In addition, other legal requirements governing federal actions are followed, including laws for protected species and habitat, wetlands, water quality, and environmental contamination. The following subsections provide a summary of these legal requirements as they pertain to this INRMP.

1.5.1 SAIA and Related Guidance

Prior to the passage of SAIA, implementation of natural resources management plans on military lands was largely discretionary. While a requirement existed to prepare natural resources plans on applicable installations, there was no legal requirement to implement those plans. The only required natural resources management activities were those associated with ESA, CWA, other statutory requirements, and DOD directives. The SAIA added a requirement for natural resource plan implementation. The SAIA requires "the Secretary of each military department to prepare and implement an integrated natural resources management plan for each military installation in the United States under the jurisdiction of the Secretary."

The SAIA requires that the Secretary of Defense carry out a program for the conservation and rehabilitation of natural resources on military installations. To facilitate the program, the Secretary of each military department is required to prepare and implement an INRMP and its updates for each installation. Furthermore, the SAIA requires that, consistent with the use of the military installations to ensure the preparedness of the Armed Forces, each INRMP shall, where appropriate and applicable, provide for:

- Fish and wildlife management, land management, forest management, and fish and wildlife-oriented outdoor recreation;
- Fish and wildlife habitat enhancement or modifications;
- Integration of, and consistency among, the various activities conducted under the INRMP and its updates;
- Establishment of specific natural resource management objectives and time frames for proposed action;
- Sustained use by the public of natural resources to the extent such use is consistent with the needs of fish and wildlife management;
- Public access to the military installation that is necessary or appropriate for sustained use by the public of natural resources to the extent that the use is consistent with the needs of fish and wildlife resources, subject to requirements necessary to ensure safety and military security;
- Enforcement of natural resource laws and regulations;
- No net loss in the capability of military installation lands to support the military mission of the installation; and
- Such other activities as the Secretary of the military department considers appropriate.

Development, implementation and revisions of this INRMP fulfills the statutory requirements under the SAIA, which is viewed as an umbrella law with regard to management of natural resources on military lands. Thus, this INRMP helps ensure JBPHH's compliance with applicable federal and

SOH laws as well as DOD and Navy guidelines, instructions, and directives that require military installations to manage and protect sensitive biological and other natural resources. A summary of the SAIA and related guidance is presented in Appendix F1.

1.5.2 National Environmental Policy Act

The SAIA of 1997 requires compliance with NEPA (16 U.S.C. 4701 et seq. [PL 91-190]), as implemented by regulations of the Council on Environmental Quality (CEQ). NEPA is a basic national charter for protection of the environment. It establishes policy, sets goals, and provides a means for carrying out environmental policy. Navy policy requires that INRMP planning and implementation comply with NEPA requirements. The INRMP Guidance for Navy Installations (DON 2005c) states that annual updates and revisions be covered under the original INRMP NEPA process unless there has been a major change in installation mission or program scope.

1.5.3 Endangered Species Act

Under the ESA (16 U.S.C. Part 1531-1544 [PL 93-205] Section 1.5.5), all federal agencies are required to carry out programs to protect and conserve federally-listed threatened and endangered species in consultation with USFWS and/or NOAA, which each have responsibilities in administering the act.

Office of the Chief of Naval Operations instruction (OPNAVINST) 5090.1C (DON 2007b) reiterates Section 7 of the ESA by requiring Navy to review its proposed and ongoing activities and identify those that may affect federally-listed species or designated critical habitats and those that may jeopardize the continued existence of proposed species or destroy or adversely modify proposed critical habitat. Further, where Navy determines that such an action may affect a listed species or a designated critical habitat, consultation with USFWS and/or NOAA Fisheries is required. Where Navy determines that the action may jeopardize the continued existence of a proposed species or destroy or adversely modify proposed critical habitat, the Navy must confer with USFWS and/or NOAA Fisheries. The required processes are detailed in 50 Code of Federal Regulations (CFR) Part 402.

The INRMP is programmatic in nature and is a planning document. As such, an action's potential to affect listed and proposed species and designated and proposed critical habitat will be assessed on a project-specific basis. Any required consultation with USFWS and/or NOAA Fisheries must be completed prior to undertaking an action affecting such species and/or habitats.

As a matter of policy, actions to protect species listed as threatened or endangered under the ESA are given top priority in the INRMP. Appendix F1 presents a summary of ESA as well as other applicable protected species and habitat laws, regulations, and requirements. As defined by the ESA, endangered species are species in danger of extinction throughout all or a significant portion of their range. Threatened species are those which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range. ESA defines "critical habitat" as the specific areas within the geographical area occupied by the species at the time it is listed on which are found those physical or biological features essential to the conservation of the species and which may require special management considerations or protection. Critical habitat may also include areas unoccupied by the species where the Secretary of the Interior has determined that such areas are essential for the conservation of the species.

Candidate species are those species that are actively being considered for listing as endangered or threatened under ESA, as well as those species that USFWS and/or NOAA has initiated an ESA status review announced in the Federal Register (FR). Neither "candidate species" nor "species of concern" carries any procedural or substantive protections under the ESA (50 CFR §424.02 and 69 FR 19975).

All Navy installations with federally-listed threatened or endangered species, proposed federally-listed threatened or endangered species, candidate species, or unoccupied habitat (as defined in Section 3 of the ESA) for a listed species where critical habitat may be designated, must structure the INRMP to avoid the designation of critical habitat. The plan may obviate the need for designating critical habitat if it specifically addresses both the benefit provided to the listed species and the provisions made for the long-term conservation of the species and habitat. The species benefit must be clearly identified in the document and should be referenced as a specific topic in the INRMP table of contents.

At the national level, the Navy and its federal SAIA partners are currently developing policies to ensure threatened and endangered species receive special management or protection through the implementation of INRMPs. As required by the new policy, the INRMP addresses maintenance and improvement of habitat and provides for the long-term conservation of threatened and endangered species.

1.5.4 Cultural Resources

The Navy is aware that there may be circumstances under which the protection and enhancement of natural resources could affect cultural resources. Appendix F1 summarizes applicable cultural resources laws, regulations, and requirements. When natural resource projects resulting from this INRMP have been precisely defined, they will be evaluated for potential effects on cultural resources. Section 106 consultation will be initiated with the State Historic Preservation Officer (SHPO), if appropriate, in accordance with the National Historic Preservation Act (NHPA), 16 U.S.C. 470 (f), as amended, and its implementing regulations, 36 CFR part 800. In addition, other potentially applicable federal cultural resource statutes include the Archaeological Resources Protection Act of 1979 (16 U.S.C. 470aa-470ll) and Native American Graves Protection and Repatriation Act (25 U.S.C. 3001 *et seq*.).

1.5.5 Wetlands and Water Quality

Wetlands and water quality are important issues addressed in this INRMP. The U.S. Army Corps of Engineers (USACE) and U.S. Environmental Protection Agency (USEPA) define wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under natural circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." The USACE Wetland Delineation Manual (1987) defines wetlands as areas having all three of the following characteristics present:

1. Vegetation: at least periodically, the land supports hydrophytes (i.e., water-loving plants);

2. Soil: the substrate is predominantly undrained, hydric soil; and

3. Water: the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

The USFWS defines wetlands more broadly and, unlike the USACE wetland delineation procedure, requires only one or more of the three wetland parameters (vegetation, soil, and water) to be present. OPNAVINST 5090.1C requires "no overall net loss" of wetlands (DON 2007b). All Navy facilities and operational actions must avoid, to the maximum degree feasible, wetland destruction and degradation. Appendix F1 provides a summary of the applicable wetlands and water quality laws, regulations, and requirements.

1.5.6 Environmental Contamination

The Comprehensive Environmental Compensation and Liability Act (CERCLA) of 1980 (42 U.S.C. §9601 et seq.), assigns USEPA the responsibility for regulating the uncontrolled release of hazardous substances nationwide. The Superfund Amendments and Reauthorization Act of 1986 (SARA) amended CERCLA so that it applies to all federal facilities. CERCLA requires that existing areas of contamination must be identified and remediated to levels protective of human health and the environment.

The Navy recognizes that the release of hazardous substances, pollutants, and contaminants into the environment may result in adverse impacts to natural resources addressed in this INRMP. The Navy Installation Restoration Program (IRP) is responsible for identifying CERCLA releases, considering risks and assessing impacts to human health and the environment (including impacts to endangered species, migratory bird species, and biotic communities), as well as developing and selecting response action(s) when it is likely that a release could result or has resulted in an unacceptable risk to human health or the environment. When appropriate, the regional or installation natural resource management staff will assist the IRP Remedial Project Manager (RPM) in identifying potential impacts to natural resources caused by the release of these contaminants.

Regional or installation natural resources staff will also participate, as appropriate, in the IRP decision-making process by communicating natural resource issues on the installation to the RPM, attending Restoration Advisory Board meetings, reviewing and commenting on IRP documents (e.g., Remedial Investigation, Ecological Risk Assessment), and ensuring that response actions are undertaken in accordance with all applicable or appropriate and relevant environmental laws to avoid and minimize impacts to natural resources on the installation.

Other applicable statutes include the Oil Pollution Act of 1990, 33 U.S.C. §2701 *et seq*.; and Federal Insecticide, Fungicide, and Rodenticide Act of 1972 (FIFRA), 7 U.S.C. 136 *et seq*. Appendix F1 provides a summary of the applicable environmental contamination laws, regulations, and requirements.

1.5.7 Coastal Zone Management

The Coastal Zone Management Act of 1972 (CZMA, 16 U.S.C. 1451-1464 [PL 92-583]) requires that all federal facilities ensure that their activities are consistent to the maximum extent practicable with the enforceable policies of an approved state Coastal Zone Management (CZM) plan. The CZMA requires the Navy to consult with the SOH CZM Program when the proposed action has the potential for reasonably foreseeable direct or indirect effects on any coastal use or resource of the SOH's coastal zone. Copies of the agency review draft INRMP were sent to the

SOH CZM Program for review. As specific natural resource projects are proposed and screened for applicability, they will be submitted to the SOH CZM Program for consistency review, if required. Appendix H16 provides a copy of the Navy's correspondence with the SOH CZM Program regarding Navy/Marine Corps De Minimis Activities under CZMA.

1.5.8 Other DOD Directives, Statutes, and Executive Orders

Appendix F1 provides an overview of other pertinent DOD directives statutes, and executive orders.

1.6 ENCROACHMENT

The Fiscal Year (FY) 03 Defense Authorization Act involves a provision, codified as Title 10 U.S.C. 2684a. The Act provides the Navy with a new tool to help control environmental encroachment through executing agreements with public and private partners to acquire real estate interests near installations to help preclude environmental restrictions on military training and testing operations. A JBPHH Encroachment Action Plan has been prepared (Navy Region Hawaii 2010).

1.7 INRMP DEVELOPMENT

Installation objectives are established, prioritized, and revisited on a regular basis. This includes consideration of natural resources management to meet both installation (mission) and regional objectives. If there are any conflicts, they can be resolved through periodic regional workshops and stakeholder discussions.

1.7.1 Review and Revision Process

The first INRMPs for PHNC, NAVMAG PH Lualualei, NRTF Lualualei, and NCTAMSPAC Wahiawa were completed in 2001 (DON 2001a, b, c) and the Natural Resources Management Plan (NRMP) for former NASBP (now known as Kalaeloa) (DON 1997) was completed in 1997. The Hickam INRMP was completed in 2007 (USAF 2007). These plans were adopted after preparation of NEPA Environmental Assessments that resulted in a Findings of No Significant Impact. This document creates no major changes to natural resources management and, therefore, no additional NEPA analysis is indicated at this time.

The SAIA requires that INRMPs be continually monitored, reviewed annually, updated if necessary, and re-approved at least every five years. This document builds upon and updates the information from the previous INRMPs, including the Hickam INRMP (USAF 2007), and the 1997 NRMP (for Kalaeloa). This plan includes natural resources surveys conducted by NAVFAC PAC in 2003 and 2006 and the Hawai'i Natural Heritage Program (HNHP) mapping conducted in 2003 and 2004 (HNHP 2003, 2004 a, b). The surveys and maps are included in Appendices A through E. The INRMP is intended for use by installation personnel in managing natural resources at JBPHH. It is a tool to guide and prioritize short (immediate to two years) and middle range (three to five years) actions and projects, as well as longer term (six to 10 years) resource conservation planning. The planning horizon for the INRMP is 10 years. During this period, changes could occur in the activity's mission, operational and security requirements, or the condition of the natural resources. For these reasons, the INRMP has been updated to ensure it reflects current requirements and management priorities.

Navy installations are required to develop the following metrics for the Assistant Secretary of the Navy using the web-based "Metrics-Builder" tool on the Natural Resources Data Call Station for the assessment of: (1) INRMP implementation; (2) partnerships/cooperation and effectiveness; (3) team adequacy; (4) INRMP impact on the installation mission; (5) status of federally-listed species and critical habitat; (6) ecosystem integrity; and (7) fish and wildlife management and public use. The Navy Conservation Metrics will be developed during the annual INRMP reviews.

1.7.2 Beneficial Partnerships and Collaborative Resource Planning

Executive Order (EO) 13352 (26 August 2004) "Facilitation of Cooperative Conservation" mandates cooperation and involvement of federal agencies with all other levels of government, non-government organizations, local interest groups, and individuals in the public involving environmental programs and planning activities. Several natural resources initiatives at JBPHH involved cooperative conservation initiatives (e.g., predator control, endangered and threatened species monitoring, alien plant removal, Migratory Bird Treaty Act [MBTA] bird protection, and habitat restoration). Cooperating agencies have included the SOH DLNR, USFWS, NOAA Fisheries, and USDA. Appendix H presents correspondence between the Navy and natural resources agencies as well as the Air Force and natural resource agencies regarding Hickam AFB relevant to JBPHH.

1.7.3 Commitment of USFWS, NOAA, and DLNR

Preparation of this INRMP, as required by SAIA, has been accomplished in cooperation with SAIA partners including USFWS, NOAA Fisheries, and SOH DLNR. This cooperation ensured that this INRMP reflected the mutual agreement of these parties concerning conservation, protection, and management of fish and wildlife resources on JBPHH. Also as required by SAIA, this INRMP reflects comments received by the Navy following public review draft of this document (Appendix K).

1.7.4 Working Group

The SAIA requires that the Navy prepare INRMPs in cooperation with appropriate federal and SOH fish and wildlife agencies. The JBPHH INRMP Working Group is composed of USFWS, NOAA Fisheries, SOH DLNR, and SOH Department of Business, Economic Development, and Tourism (DBEDT) CZM Program (Table 1-1). Cooperation for this INRMP began early: a kickoff meeting and discussion was held June 2006 with representatives of the Working Group members in attendance. Natural resources management planners maintained open lines of communication with identified Working Group members throughout the planning process. Working Group members were asked to evaluate and comment on the agency review draft INRMP documents. All comments and suggestions from Working Group members were evaluated and addressed in the final INRMP (Appendix K).

This INRMP was developed in accordance with the SAIA as well as the Deputy Under Secretary of Defense (Installations and Environment) Memorandum, 10 October 2002, "Implementation of Sikes Act Improvement Act" and the OPNAVINST 5090.1C Environmental and Natural Resources Program (DON 2007b). In accordance with SAIA, management options reflect the mutual agreement of USFWS, NOAA, SOH DLNR, and other interested agencies in the conservation, protection, and management of natural resources. All such management options have the potential to conflict with JBPHH's daily operations should the military mission or security requirements change in the future. Re-evaluation of and adjustments to these management

actions may be necessary should such mission changes occur. Appendix I8 provides memorandum of understanding for the implementation of INRMPs and correspondence with Working Group Members.

Table 1-1: INRMP Update Working Group Members

Point of Contact*	Phone Number	Address	Email address
U.S. Fish and Wildlife Service (USFWS), Pacific Islands			
Ms. Patrice Ashfield, Deputy Project Leader	808.792.9400	300 Ala Moana Blvd. Room 3-122 Honolulu, HI 96813	patrice_ashfield@fws.gov
Mr. Dave Ellis, Refuge Manager	808.637.6330 ext. 26	Same as above	dave_ellis@fws.gov
Ms. Paula Levin Coastal Conservation Program	808.792.9400	Same as above	paula_levin @fws.gov
National Oceanic and Atmospheric Administration (NOAA) Fisheries			
Dr. Robert Schroeder, Habitat Division	808.944.2158	1601 Kapiolani Boulevard, Suite 1110 Honolulu, HI 96814	robert.schroeder@noaa.gov
Mr. Lance Smith, ESA Coordinator	808.944.2258	Same as above	lance.smith@noaa.gov
Ms. Jayne Le Fors, NEPA Specialist	808.944.2277	Same as above	jayne.lefors@noaa.gov
Mr. Donald Hubner, ESA specialist and DOD liaison	808.944.2233	Same as above	Donald.Hubner@noaa.gov
State of Hawai'i (SOH) Department of Land and Natural Resources (DLNR)			
Mr. Paul Conry, Administrator, Division of Fish and Wildlife (DOFAW)	808.587.0166	1151 Punchbowl Street, Room 325 Honolulu, HI 96813	paul.j.conry@hawaii.gov
Mr. Robert Nishimoto, Division of Aquatic Resources (DAR)	808.587.0100	1151 Punchbowl Street, Room 330 Honolulu, HI 96813	DLNR.aquatics@hawaii.gov
Mr. Daniel S. Quinn, Division of State Parks	808.587.0290	1151 Punchbowl Street, Room 310 Honolulu, Hawai`i 96813	dan.quinn@hawaii.gov
Mr. Sam Lemmo, Office of Conservation and Coastal Lands	808. 587.0377	Kalanimoku Building, 1151 Punchbowl St., Room 131, Honolulu, HI 96813	dlnr.occl@hawaii.gov
Mr. Jason Misaki, O'ahu Wildlife Manager (DOFAW)	808.973.9786	2135 Makiki Heights Dr Honolulu, HI 96822	Jason.c.misaki@hawaii.gov
SOH Coastal Zone Management (CZM) Program, Department of Business, Economic Development, and Tourism (DBEDT)			
Mr. John Nakagawa, Planner	808.587.2878	P.O. Box 2359 Honolulu, HI 96804	jnakagawa@dbedt.hawaii.gov

* individuals listed participated in all or part of the INRMP process from June 2006 to April 2011

1.7.5 Stakeholders

Stakeholders in the public and private sectors were identified early in the process of updating the INRMP and were interviewed in preparation of the INRMP document. Table 1-2 provides a listing of Stakeholders consulted as part of the INRMP update process. Stakeholders were asked to evaluate and comment on the public review draft INRMP document (Appendix K).

1.7.6 Public Participation

Through public notices in the Honolulu Advertiser and the Honolulu Star-Bulletin on January 15, 16, and 17, 2010, the general public was encouraged to provide comments on the public review draft. In addition, a notice of availability was published in SOH Office of Environmental Quality Control's Environmental Notice in January 2010. However, no comments were received.

1.8 GOALS AND OBJECTIVES

Goals for the INRMP represent the long-range (10-15 years) intentions of CNRH with respect to natural resources under its responsibility. The primary goal of the INRMP is to support and sustain the military mission of JBPHH while managing, protecting, and enhancing biological diversity and ecosystem integrity of military lands and waters and all associated threatened and endangered species and their habitats. Furthermore, it is a goal of the INRMP to provide multiple-use programs for the management, conservation, and protection of renewable natural resources including wildlife, soil, water, and natural areas in conformance with applicable federal and SOH natural resource laws, regulations, and policies.

1.9 COOPERATIVE MANAGEMENT

The operations and natural resources management communities at JBPHH share a common goal: a sustainable landscape that can accommodate continued operations with minimal restrictions placed upon it. This shared value is attainable only through cooperation and collaboration between CNRH and each activity. Open communication and information sharing is crucial to their respective missions. The JBPHH IEPM is the primary point of contact for all JBPHH natural resources issues.

Because ecosystems do not follow political or social boundaries, a coordinated approach at JBPHH includes: (1) early and regular coordination with Working Group members; (2) incorporation of ecosystem management goals into strategic, financial, and program planning and design budgets for JBPHH; and (3) the prevention of duplication of effort and minimization of inefficiencies.

Ecosystem management depends upon participation by diverse Working Group members and Stakeholders and their ability to develop a shared vision of what constitutes a desirable future condition for the region of concern. At JBPHH, this means considering the mission as well as the relationship of the installation to surrounding communities and regional environmental efforts.

Table 1-2: INRMP Update Stakeholders

Point of Contact	Phone Number	Address	Email address
Commander Navy Region Hawaii (CNRH)			
LCDR Lore Aguayo Assistant Regional Engineer, NAVFAC HI Code ARE	808.473.4137 ext. 241	850 Ticonderoga Street, Suite 110, Pearl Harbor, HI 96860-5101	lore.aguayo@navy.mil
Ms. Elizabeth Nashold, Assistant Regional Engineer and Deputy Regional Environmental Coordinator, NAVFAC HI Code ARE 1	808.473.4137 ext. 240	850 Ticonderoga Street, Suite 110, Pearl Harbor, HI 96860-5101	elizabeth.nashold@navy.mil
Ms. Patricia Colemon, Environmental Outreach Coordinator, NAVFAC HI Code ARE 1	808-473-4137 ext. 224	850 Ticonderoga Street, Suite 110, Pearl Harbor, HI 96860	patricia.colemon@navy.mil
Ms. Rebecca Hommon, Environmental Attorney	808.473.4731	850 Ticonderoga Street, Suite 110, Pearl Harbor, Hawai'i 96860	rebecca.hommon@navy.mil
Mr. David Sullivan, Regional Environmental Coordinator	808.473.4141	850 Ticonderoga Street, Suite 110, Pearl Harbor, Hawai'i 96860	david.m.sullivan1@navy.mil
Naval Facilities Engineering Command, Hawaii (NAVFAC HI)			
Dr. Aaron Hebshi, Natural Resources Program Manager, NAVFAC Code HIEV1	808.471.1171 ext. 244	400 Marshall Road, Pearl Harbor, HI 96860	aaron.hebshi@navy.mil
Mr. Matt Flach, Landscape Architect	808-474-3815, 400	Marshall Road, Pearl Harbor, HI 96860-3139;	matt.flach@navy.mil
Mr. Alan Sugihara, Pearl Harbor Environmental Coordinator	808.71.5094	Building 223 South Avenue Pearl Harbor, HI 96860-3139	alan.sugihara@navy.mil
Mr. Norman Kawamoto Supervisor, Storefront Environmental Coordinator, PHNC	808.474.2323	Building 223 400 South Marshall Road Pearl Harbor, HI 96860-3139	norman.kawamoto@navy.mil
Terrance Tengan, Environmental Coordinator, NAVMAG PH Lualualei and West Loch Branches and Kalaeloa	808.471.1111 ext. 320	Building 587 562 G avenue Ewa Beach, HI 96706	terence.tengan@navy.mil
Ms. Michelle Delaney, NCTAMS PH Storefront Environmental Coordinator	808- 653-9850	400 Marshall Road, Pearl Harbor, HI 96860-3139	Michelle.delaney@navy.mil
Mr. Ronnie Lanier, JBPHH IEPM	808.449.3173	75 H Street, Hickam AFB HI 96853	Ronnie.lanier@navy.mil

Table 1-2: INRMP Update Stakeholders (Continued)

Point of Contact	Phone Number	Address	Email address
Mr. Andy Huang, NEPA Branch Head	808.471.1171 ext. 245	400 Marshall Road, Pearl Harbor HI 96860	Andy.huang@navy.mil
Mr. Aaron Poentis, Regional Environmental Director	808.471.1171 ext. 226	400 Marshall Road, Pearl Harbor HI 96860	Aaron.poentis@navy.mil
Commander Pacific Fleet (COMPACFLT or Fleet)			
Mr. Larry Foster, Fleet Environmental Officer	808.471.4235	250 Makalapa Drive, Pearl Harbor, Hawai'i 96860	larry.foster@navy.mil
Ms. Julie Rivers, Marine and Natural Resources Program Manager	808.474.6391	Same as above	julie.rivers@navy.mil
Naval Facilities Engineering Command, Pacific (NAVFAC PAC)			
Dr. Angela Anders, Supervisory Fish and Wildlife Biologist	808.472.1087	Same as above	angela.anders@navy.mil
Dr. Cory Campora, Entomologist	808.472.1408	258 Makalapa Drive, Suite 100, Pearl Harbor, HI 96860	cory.campora@navy.mil
Mr. Justin Fujimoto, Natural Resources Specialist, Code EV22	808.472.1407	Same as above	justin.fujimoto@navy.mil
Mr. Stephen H. Smith, Marine Ecologist, Code EV22	808.472.1405	Same as above	stephen.h.smith@navy.mil
Dr. Sean Hanser, Supervisory Marine Resources Biologist	808.472.1388	Same as above	sean.hanser@navy.mil
Ms. Laura Williams, Botanist	808.472.1406	Same as above	laura.l.williams@navy.mil
Mr. Joel Helm, Biosecurity specialist	808.472.1046	Same as above	joel.a.helm@navy.mil
Frans, Juola, Avian Ecologist	808.472.1391	Same as above	frans.juola@navy.mil
Mr. Stephan Lee, Entomologist, Code EV22	808.472.1384	Same as above	stephan.g.lee@navy.mil
U.S. Department of Agriculture (USDA) Animal Plant Health Inspection Service (APHIS) Wildlife Service (WS)			
Mr. Mark Ono, USDA, APHIS/WS	808.861.8575 ext. 21	3375 Koapaka Street, Suite H-420, Honolulu, HI 95819-1898	mark.s.ono@aphis.usda.gov
State of Hawai'i(SOH) Hawai'i Community Development Authority			
Ms. Tesha Malama, Kalaeloa Community Development District	808.594.0300	677 Ala Moana Blvd., Suite 1001, Honolulu, Hawaii 96813	Not available

Table 1-2: INRMP Update Stakeholders (Continued)

Point of Contact	Phone Number	Address	Email address
State of Hawai'i(SOH) Department of Health			
Mr. Dennis Lau, Clean Water Branch, Environmental Management Division.	Not available	P.O. Box 3378 Honolulu, HI 96801-3378	Not available
City and County of Honolulu (CCH) Department of Planning and Permitting			
Mr. David Tanoue, Department of Planning and Permitting	808.768.8000	City and County of Honolulu,650 So. King Street Honolulu, HI 96813	Not available
O'ahu Invasive Species Committee (OISC)			
Ms. Rachel Neville Operations Manager	808.453.6112	2551 Waimano Home Road Pearl City, HI 96782	Not available

1.10 ADAPTIVE MANAGEMENT

Ecosystems are constantly changing. Understanding of ecosystems and natural communities is constantly evolving through science and adaptive management. The Navy is committed to the collection, maintenance, and use of scientific data required for making sound natural resources and land use management decisions. NAVFAC PAC Natural Resources staff continues to update botanical, bird, and wildlife surveys in order to understand how these communities are changing over time and to better manage these resources in a sustainable manner.

Management practices must accommodate changes in both the ecosystem and the understanding of these systems. This INRMP will be reviewed annually and updated again in five years. The CNRH Natural and Cultural Resources Program Manager, NAVFAC HI Storefront Environmental Coordinators, and NAVFAC PAC Natural Resource staff continue to adapt environmental management efforts when new information is available or significant changes to the ecosystem occur.

1.11 ECOSYSTEM MANAGEMENT

Management of installation natural resources will support sustainable military use through the application of an integrated approach to ecosystem management. Ecosystem management is an interdisciplinary planning and management process that focuses on identifying, restoring, and maintaining natural communities in support of the military mission and other sustainable activities. The principles of ecosystem management have been incorporated in DOD Conservation Instruction 4715.3.

The ecosystem approach to natural resources management has the overarching goal of protecting the properties and functions of natural ecosystems. Ecosystem management for JBPHH includes inventory and monitoring; protection and damage prevention; soil, water, and

vegetation management; wildlife population management; research; enforcement; and awareness.

The ecosystem management approach depends on specific and measurable objectives and criteria with which to evaluate activities in the ecosystem. This INRMP includes specific measurable goals and objectives, and task schedules for JBPHH (Chapter 9).

1.12 TRAINING OF NATURAL RESOURCES PERSONNEL

OPNAVINST 5090.1C Appendix P provides a summary of the Formal Navy Environmental, Natural and Cultural Resources Training Course and Billet-Specific Course (DON 2007b). Navy natural resources personnel receive training based on the billet or job that they fulfill. Required training for the NAVFAC HI Natural Resource Program Manager, JBPHH Environmental Storefront Coordinators, NAVFAC HI Natural Resource staff, and NAVFAC PAC Natural Resource staff includes courses on environmental protection, basic and advanced environmental law, environmental negotiation, NEPA application, health and environmental risk communications, natural resource management, DOD MBTA training, DOD water and air quality management, environmental laws and regulations, and air installation compatible use zones (AICUZ).

In addition, the NAVFAC HI Natural Resources Program Manager also receives training for the Navy's environmental restoration program, uniform federal policy for quality assurance, environmental background analysis, ecological and human health risk assessment, environmental geographical information system (GIS)/geostatistics, optimizing remedy selection and site closeout process, munitions response site management, historic preservation law and Section 106 Compliance, cultural resources management laws and regulations, and health and environmental risk communication.

1.13 MANAGEMENT STRATEGY

The Navy uses the following three criteria to determine if a plan provides adequate special management or protection:

1.13.1 Criteria 1. Conservation Benefit

The plan provides a conservation benefit to the species. The cumulative benefits of the management activities identified in a management plan, for the length of the plan, must maintain or provide for an increase in a species' population, or the enhancement or restoration of its habitat within the area covered by the plan (i.e., those areas deemed essential to the conservation of the species). A conservation benefit may result from reducing fragmentation of habitat, maintaining or increasing populations, insuring against catastrophic events, enhancing and restoring habitats, buffering protected areas, or testing and implementing new conservation strategies.

1.13.2 Criteria 2. Implementation of the Plan

The plan provides assurances that the management plan will be implemented. Persons charged with plan implementation are capable of accomplishing the objectives of the management plan and have adequate funding for the management plan. They have the authority to implement the

plan and have obtained all the necessary authorizations or approvals. An implementation schedule (including completion dates) for the conservation effort is provided in the plan.

1.13.3 Criteria 3. Management Effectiveness

The plan provides assurances that the conservation effort will be effective. The following criteria will be considered when determining the effectiveness of the conservation effort. The plan includes (1) biological goals (broad guiding principles for the program) and objectives (measurable targets for achieving the goals); (2) quantifiable, scientifically valid parameters that will demonstrate achievement of objectives, and standards for these parameters by which progress will be measured, are identified; (3) provisions for monitoring and, where appropriate, adaptive management; (4) provisions for reporting progress on implementation (based on compliance with the implementation schedule) and effectiveness (based on evaluation of quantifiable parameters) of the conservation effort are provided (this goal will be accomplished at the annual INRMP review and update, in coordination with the appropriate state fish and wildlife agency and USFWS); and (5) a duration sufficient to implement the plan and achieve the benefits of its goals and objectives. The INRMPs are five-year plans but may be extended further than five years if installation mission or natural resources do not change, or changes are minimal. This is a time period long enough to seek funding for projects, implement those projects, and monitor and report progress. At the end of the five-year period the INRMP will be reviewed and updated or rewritten if necessary to continue protection and enhancement for threatened and endangered species and habitats.

CHAPTER 2
GENERAL INSTALLATION DESCRIPTION

CHAPTER TWO: GENERAL INSTALLATION DESCRIPTION

2.1 DESCRIPTION OF JBPHH FACILITIES

Naval Station Pearl Harbor and Hickam AFB combined to form JBPHH on January 31, 2010. The Navy acts as the Component Lead for JBPHH; therefore CNRH oversees all Base Operating Support. This responsibility involves 24,895 ac (10,075 ha) of land and approximately 68,081 ac (27,552 ha) of water (Figure 2-1, Table 2-1).

2.1.1 Areas Included in the INRMP

2.1.1.1. Land Areas

This INRMP includes those JBPHH lands with natural resource value that are owned, leased, or otherwise controlled by the Navy. These areas are summarized in Table 2-1 and shown on Figure 2-1.

2.1.1.2. Navy Defensive Sea Area and Training Areas

The Navy Defensive Sea Area (NDSA) O‘ahu is shown on Figure 2-2 and includes Pearl Harbor and Pearl Harbor Entrance Channel (PHEC), and waters immediately south of PHEC. NSDAs are reserved zones established by the President under EO 10104 to protect certain coastal facilities of military significance. The Navy has exclusive use of the outer Pearl Harbor NDSA. The Navy follows strict SOPs and mitigation measures developed in consultation with resource agencies to ensure that the Navy can maintain mission essential operations by using prudent measures to protect sensitive resources while operating in the outer Pearl Harbor NDSA. The Navy has management authority over natural resources in the outer Pearl Harbor NDSA and it is included in the scope of this document.

The Navy has natural resource management authority for the following offshore Navy training areas associated with JBPHH (Figure 2-2): Barbers Point Underwater Range and Ewa Training Minefield. The Barbers Point Underwater Range is closed to all surface craft, swimmers, divers, and fishermen except to craft and personnel authorized by the Navy (33 CFR 334.1360, 33 CFR 334.1370). With regard to the Ewa Training Minefield, vessels are not allowed to anchor in the area at any time; dredging, dragging, seining, or other fishing operations which might foul underwater installations are prohibited. Boating, fishing (with some exceptions), and other surface activities are authorized in the Ewa Training Minefield (33 CFR 334.1400).

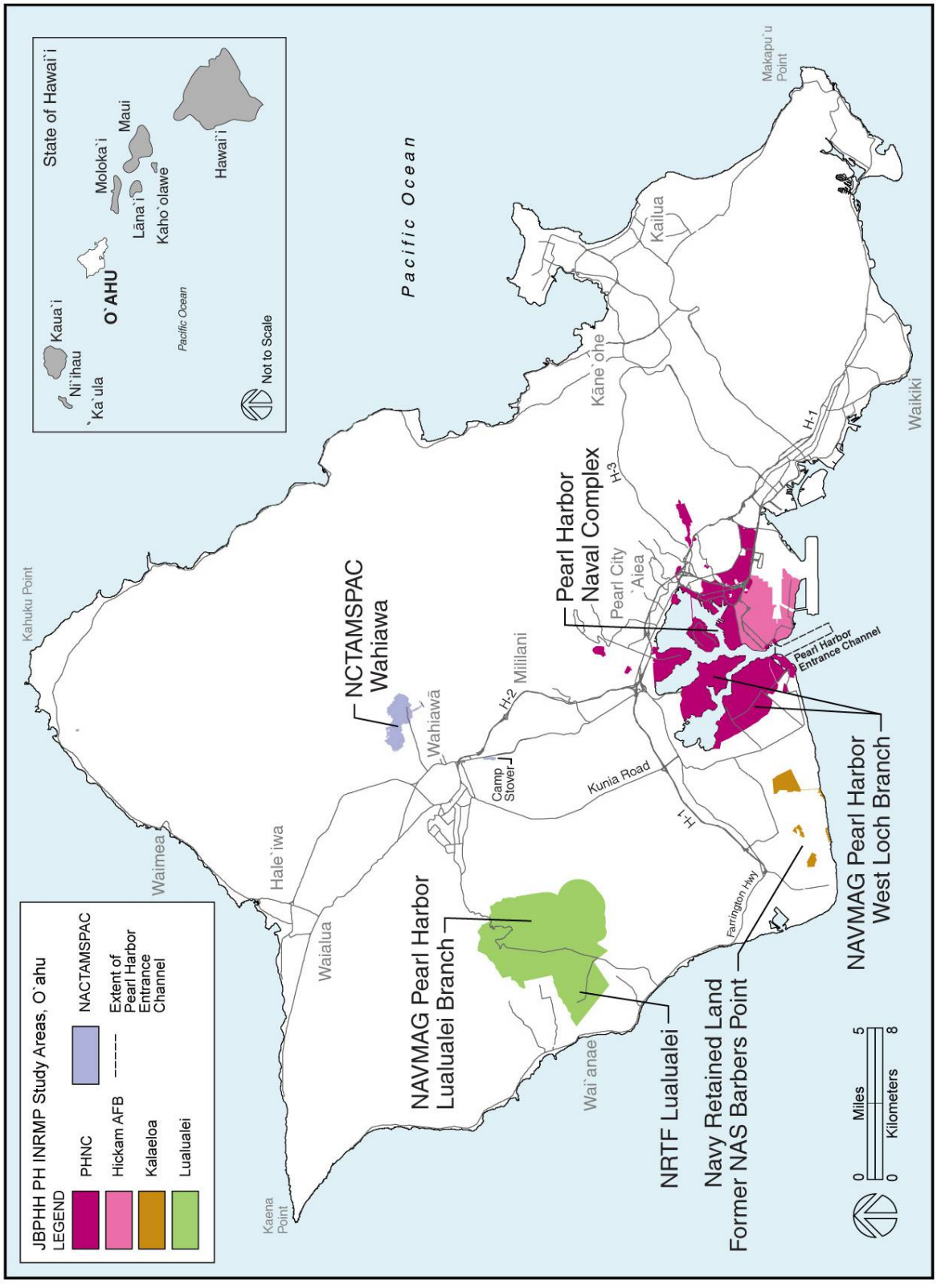


Figure 2-1: JBPHH Study Area, O'ahu

Table 2-1: Lands and Waters Owned, Leased, or Otherwise Controlled by JBPHH

INRMP Study Area	Approximate Land Area in ac (ha)	Land Ownership	Land Use and Types of Operations	Requires a Natural Resources Management Plan
PHNC	Approximately 6,982 ac (2,826 ha) land and approximately 68,081 ac (27,552 ha) of water	Navy	Areas with Significant Natural Resources: (1) intertidal areas and waters of Pearl Harbor, the NDSA, and offshore training areas; (2) undeveloped portions of Makalapa Crater[1]; (3) undeveloped portions of Pearl City Peninsula; (4) undeveloped portions of Red Hill Storage Area; (5) undeveloped portions of Waiawa Watershed; and (6) undeveloped portions of NAVMAG PH West Loch Branch (including Waipio Peninsula. The intertidal areas and waters of Pearl Harbor are used for ship berthing, maintenance, and repair as well as recreation; the Makalapa Crater, excluding family housing, is an administrative complex; Pearl City Peninsula, excluding family housing, is primarily used for warehousing, operations, and wildlife refuge; Red Hill Storage area is primarily used for supply and public works; and Waiawa Watershed is primarily used for supply and public works. NAVMAG PH West Loch Branch contains 4,082 ac (1,652 ha) including magazines, operations and maintenance buildings, community and personnel support, wharves for loading and unloading of explosives and other military ordnance and materiel, and open lands within the established explosives safety quantity distance (ESQD) arcs.	Yes, includes federally-listed birds, marine mammals, and sea turtles; MBTA-protected birds; wildlife refuges; wetlands; and outdoor recreation areas. Includes historic fishponds.

[1] Place names for JBPHH INRMP are listed in a place name key at the beginning of this plan (see table of contents) which provides the official names for these land areas.

Table 2-1: Lands and Waters Owned, Leased or Otherwise Controlled by JBPHH (Continued)

INRMP Study Area	Approximate Land Area in ac (ha)	Land Ownership	Land Use and Types of Operations	Requires a Natural Resources Management Plan
PHNC (continued)	Approximately 1,953 ac (790 ha)	Navy	Highly Developed and Industrialized Areas: (1) Beckoning Point; (2) Bishop Point; (3) Federal Fire Department (FFD); (4) Ford Island; (5) Fort Kamehameha Wastewater Treatment Plant (WWTP); (6) Moanalua Shopping Center (MSC)/Navy Exchange (NEX)/Commissary; (7) Naval Sea (NAVSEA) Inactive Ships On-Site Maintenance Office (NISMO); (8) Naval Station; (9) Navy-Marine Golf Course; (10) Ohana Nui; (11) Public Works Center Compound; (12) Richardson Recreation Center and 'Aiea Landing; (13) the Salt Lake Storage Area; and (14) the Pearl Harbor Naval Shipyard (Shipyard)(shown on Figure 3-6). Although most of the operational facilities are consolidated in the highly developed core fronting Southeast Loch, other land areas around the harbor are used for supply, recreation, other operations, logistic support including ship berthing, repair and maintenance, supply and storage, and public works support.	Yes, contains mature and significant trees and landscapes. Some sites are located adjacent to the coastline and/or wetland areas.
	Approximately 1,299 ac (526 ha)	Navy	Family Housing Communities: (1) Catlin Park; (2) Doris Miller Park; 3) Ford Island; (4) Halawa; (5) Hale Alii; (6) Hale Moku; (7) Halsey Terrace; (8) Hokulani; (9) Hospital Point; (10) Little Makalapa; (11) Makalapa; (12) Maloelap; (13) Mānana; (14) Marine Barracks; (15) McGrew Point; (16) Moanalua Terrace; (17) Pearl City Peninsula; (18) Radford Terrace; and (19) Red Hill (as shown on Figure 3-7).	Yes, contains mature and significant trees and landscapes. Some sites are located adjacent to the coastline and/or wetland areas.
Total PHNC	78,315 ac (37,566 ha)			
Lualualei	Approximately 7,498 ac (3,034 ha)	Navy	Operational Areas of NAVMAG PH Lualualei Branch: (1) extensive munitions magazine complex; (2) warehousing; (3) operating buildings; (4) community and personnel support facilities; and (5) a considerable amount of open space within the ESQD arcs.	Yes, includes federally-listed plants and bird species; critical habitat; MBTA-protected birds; wetland areas including a wildlife refuge.
	Approximately 1,700 ac (687 ha)	Navy	Operational Areas of NRTF Lualualei: Used to transmit state-of-the-art high and low frequency radio signals for the navigation of Navy vessels throughout the Pacific; signals create high-density electromagnetic radiation (EMR) hazards; EMR zones are designated around transmitter sites.	Yes, federally-listed plants and bird species and MBTA-protected birds, includes a wetland/wildlife refuge, and agricultural outleases.

Table 2-1: Lands and Waters Owned, Leased or Otherwise Controlled by JBPHH (Continued)

INRMP Study Area	Approximate Land Area in ac (ha)	Land Ownership	Land Use and Types of Operations	Requires a Natural Resources Management Plan
Total Lualualei	9,198 ac (3,722 ha)			
NCTAMSPAC	700 ac (283 ha)	Navy	Operational Areas of NCTAMSPAC Wahiawa: Contains operations, open space around antennas, and family housing and community support facilities.	Yes, mature and significant trees and landscapes, MBTA-protected birds, and native mesic forest.
	40 ac (16 ha)	Navy	Family Housing Communities: Camp Stover.	Yes, mature and significant trees.
Total NCTAMSPAC Wahiawa	740 ac (299 ha)			
Kalaeloa	2,054 ac (831 ha) land	Navy	Areas with Significant Natural Resources: (1) NAVFAC Hawaii Biosolids Treatment Facility; (2) Morale, Welfare, and Recreation (MWR) Barbers Point Golf Course and Stables; (3) MWR Nimitz Beach; and (4) MWR White Plains Beach; (5) Lot 58-D; (6) Lot 58-F; (7) Lot 73-A; and (8) Lot 74-D. Highly Developed and Industrialized Areas: (1) Defense Reutilization and Marketing Offices (DRMO) office and warehouse space; (2) NAVFAC HI West O'ahu Shop; (3) Lot 58-B; and (4) Lot 58-G.	Yes. Sensitive habitats, outdoor recreational facilities.
Hickam	2,669 ac (1,080 ha)	USAF	Operational areas of Hickam and Hickam POL Pipeline : Land use categories include housing, community service, medical, outdoor recreation, open space/roads, light industrial, aircraft operations and maintenance, airfield, and open water.	Yes, includes federally-listed bird species and sea turtles; MBTA-protected birds; marine mammals may occur in adjacent coastal waters; includes wetlands; and outdoor recreation areas.
Total JBPHH	Total: approximately 92,976 ac (37,626 ha); Land: approximately 24,895 ac (10,075 ha); Water: approximately 68,081 ac (27,552 ha) water			

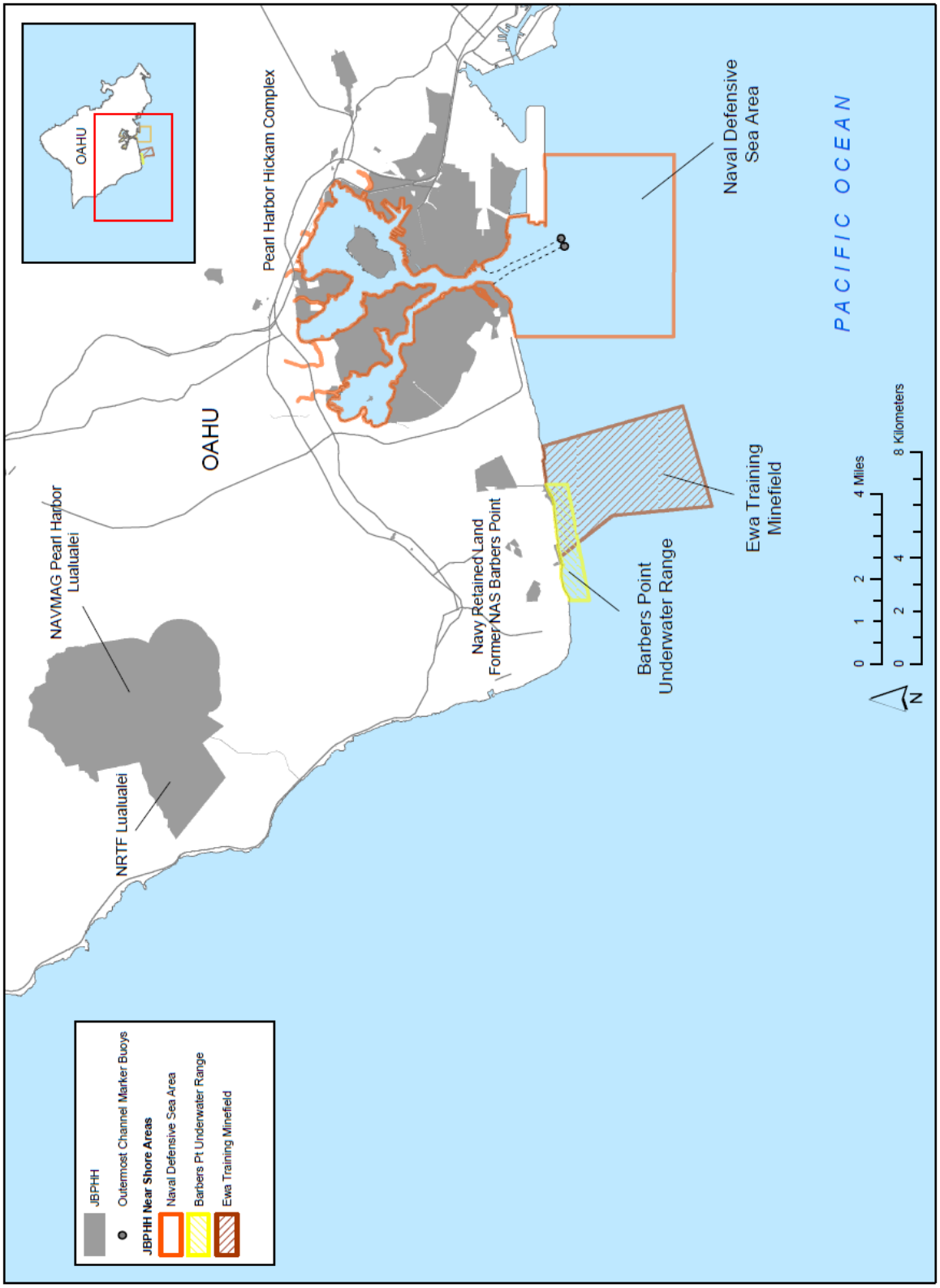


Figure 2-2: NDSA and Off Shore Training Areas, O'ahu

2.1.2 Areas Not Included in the INRMP

Very small, non-contiguous Navy sites are not included in the INRMP as they consist of leased building space only or have no significant resources within their own boundaries. The Navy utilizes support facilities, operated by others, on O'ahu; however, these facilities are not managed or operated by the Navy and, therefore, are not included in the scope of this document.

2.2 GENERAL PHYSICAL ENVIRONMENT

The discussion of the general physical environment is divided into five subsections (2.2.1 through 2.2.5): (1) physical geography; (2) topography; (3) climate; (4) geology; and (5) hydrology.

2.2.1 Physical Geography

2.2.1.1 Hawaiian Islands

The Hawaiian Islands form an archipelago of 19 islands and atolls, numerous small islets, and undersea seamounts trending northwest to southeast in the North Pacific Ocean between latitudes 19 degrees (°) North and 29° North. The archipelago extends 1,500 miles (mi) (2,400 kilometer [km]) from the Island of Hawai'i in the south to northernmost Kure Atoll (Juvik *et al.* 1998).

2.2.1.2 O'ahu

There are four major geomorphic provinces on the Island of O'ahu: Ko'olau Range, Wai'anae Range, Schofield Plateau, and Coastal Plain. Two massive shield volcanoes which arose from the floor of the Pacific Ocean initially formed the island: (1) Wai'anae Volcano; and (2) Ko'olau Volcano. Eroded remnants of these shield volcanoes, the Ko'olau and Wai'anae Ranges, compose the island and are exposed as long, narrow, nearly parallel mountain ridges, which are separated by the Schofield Plateau. The Coastal Plain overlies the Ko'olau Volcano at the north and south ends of the Schofield Plateau. The majority of PHNC is located on the coastal plain south of Schofield Plateau (Stearns 1985).

1. Ko'olau Range

The Ko'olau Range forms the eastern part of the island and lies behind Honolulu. Pu'u Kōnāhuanui, the highest point, is 3,105 feet (ft) (946 meters [m]) high. The range is 37 mi (60 km) long and is deeply eroded by streams (Stearns 1985).

2. Wai'anae Range

The Wai'anae Range, forming the western part of the island, is 22 mi (35 km) long. Mount Ka'ala, the highest point on O'ahu, is 4,025 ft (1,227 m) high (Stearns 1985).

3. Schofield Plateau

Banking of the younger Ko'olau flows against the older Wai'anae Range and erosion of the two mountain ranges formed the Schofield Plateau in the central portion of O'ahu (Stearns 1985).

4. Coastal Plain

The Coastal Plain lies mostly on the ponded lavas of the Ko'olau Volcano north and south of the Schofield Plateau. The 'Ewa Plain, lying west of Pearl Harbor, is the most extensive part of the Coastal Plain. The Waipi'o and Pearl City Peninsulas project into Pearl Harbor. The Honolulu Plain extends eastward from Pearl Harbor and is occupied by the city of Honolulu including Waikīkī. The northern sector of the Coastal Plain is called the Waialua-Hale'iwa Plain and the northeastern sector is the Kahuku Plain (Stearns 1985).

2.2.2 Topography

The island of O'ahu consists of two nearly parallel mountain ranges – Ko'olau and Wai'anae – that trend northwest and southwest and are separated by the Schofield Plateau. A large, relatively flat, gently sloping coastal plain borders the plateau on the south. Largely located on the south-central shore of O'ahu, PHNC lies primarily within this coastal plain.

2.2.3 Climate

Hawai'i is located approximately 2,100 mi (3,380 km) south and west of California at the edge of the Tropical Zone within the belt of cooling northeasterly trade winds. The climate in Hawai'i is notably mild with low day-to-day and month-to-month variability. Two seasons are generally recognized in Hawai'i: (1) summer, which commonly is defined as the period from May through September; and (2) winter, which is defined as the period from October through April (Juvik *et al.* 1998).

On the island of O'ahu, a combination of prevailing northeasterly tradewinds, present 70 percent of the time, and milder southerly winds blowing 15 percent of the time provide for virtually constant air movement on the windward side of the island; while the leeward side is often hotter due to less consistent prevailing winds. Generally, the warm moist winds are forced to rise over windward coasts and slopes, thereby causing cloudiness and substantial rainfall. Descending air in the leeward areas contributes to a sunny and dry climate.

2.2.4 Geology

This subsection includes a general discussion of the geology of (1) Hawaiian Islands; and (2) O'ahu, including the four major geomorphic provinces of the island.

2.2.4.1 Hawaiian Archipelago

The Hawaiian Islands are the exposed peaks of large volcanic mountain ranges, most of which lie beneath the sea, that constitute the Hawaiian Ridge. They were produced by a series of volcanic eruptions during the Pliocene Epoch. These volcanic eruptions are a result of a plume of hot rock anchored 100 mi (161 km) beneath the Pacific (Tectonic) Plate and the movement of the plate across that "hot spot." The hot spot has continuously fed magma (molten rock) through the crust to fuel countless volcanic eruptions over the past 40 million years as the

Pacific Plate has continued to move west-northwestward at a rate of 3.5 inches (in) (9 centimeter [cm]) a year. The plate has rafted approximately 129 volcanoes in all including the 19 volcanoes making up the major islands of Hawai'i (Juvik *et al.* 1998).

2.2.4.2 O'ahu

O'ahu was initially formed by two massive, extinct shield volcanoes: Wai'anae on the west and Ko'olau on the east. These volcanoes are separated by the Schofield Plateau of central O'ahu which was formed by the lavas from the Ko'olau Range banking against the older Wai'anae Range. North and south of the Schofield Plateau is O'ahu's coastal plain, which is composed of marine and terrigenous sediments deposited when the sea stood at a higher level or stand.

1. Wai'anae Volcano

Wai'anae Volcano consists of shield lavas ranging from 3.5 to 3.9 million years old overlain by a thick sequence of postshield-stage alkalic basalt (rich in sodium and potassium) (3.2 to 3.5 million years old). A posterosional sequence of lava is 2.5 million years old and represents a postshield eruption. The erosional unconformity that separates these lavas from the earlier part of the postshield stage has been attributed to a large landslide to the southwest, named the Wai'anae Slump (Juvik *et al.* 1998). Huge valleys have been carved by erosion into the Wai'anae Range; most of them discharge to the southwest. The Wai'anae Volcano became extinct before the Ko'olau as evidence by the lava flows of the Ko'olau overlapping the eroded, soil-covered Wai'anae lava flows. The mountain range is nearly buried in its own waste as a result of submergence and extensive erosion (Stearns 1985).

2. Ko'olau Volcano

The Ko'olau Volcano consists of eruptive products of the shield (2.5 to 1.7 million years old) and rejuvenated stages; no post-shield lavas are known. Lavas of the Ko'olau Volcanic Series consist entirely of thin, narrow, basaltic lava flows piled one upon the other like shingles, with minor amounts of volcanic ash and numerous dikes (Stearns 1985). A caldera complex in the Kailua region on the northeast shore of the island was bisected by the catastrophic Nu'uanu landslide. Rejuvenated-stage lavas mainly erupted in the Honolulu area, hence their name: the Honolulu Volcanic Series. Although some of these rejuvenated lavas could be considerably younger, most lavas, which include flows of alkalic basalt, basanite, nephelinite, and melilite, appear to be older than 100,000 years. These eruptions tended to be explosive, and most vents along the coast produced tuff cones such as Salt Lake, Makalapa, and Āliamanu Craters. Flows from inland eruptions were funneled down valleys such as Mānoa and Nu'uanu, creating flat valley floors (Juvik *et al.* 1998).

3. Schofield Plateau

The lavas from the Ko'olau Range banking against the older Wai'anae Range formed the Schofield Plateau. Considerable alluvium from the Wai'anae Range is piled against and interfingers with the Ko'olau lavas on the west side of the plateau and along the rim of Kaukonahua Valley. Much of the area between Pearl Harbor and Waipi'o is covered with a thin veneer of alluvium (Stearns 1985).

4. Coastal Plain

The Coastal Plain lies mostly on the ponded lavas of the Ko'olau Volcano north and south of the Schofield Plateau. The plain is composed chiefly of marine sediments deposited on lavas when sea level was higher in the mid-Pleistocene time. The 'Ewa (coral) Plain, lying west of Pearl Harbor, is the most extensive part of the Coastal Plain. The Waipi'o and Pearl City Peninsulas project into Pearl Harbor. The Honolulu Plain extends eastward from Pearl Harbor and is occupied by the city of Honolulu including Waikīkī. The northern sector of the Coastal Plain is called the Waialua-Hale'iwa Plain and the northeastern sector is the Kahuku Plain (Stearns 1985).

2.2.5 Hydrology

The discussion of the PHNC hydrology is divided into three subsections: (1) surface water resources; (2) hydrogeology (groundwater resources); and (3) aquifer characteristics.

2.2.5.1 Surface Water Resources

Surface water resources are discussed in Sections 3.2.6, 4.2.6, 5.2.6, and 6.2.6.

2.2.5.2 Hydrogeology

On O'ahu, groundwater occurs chiefly as either basal water, a lens of fresh to brackish water that floats on seawater, or high-level water, freshwater that does not rest on sea water. Although they are surrounded by seawater, the Hawaiian Islands are underlain by large quantities of fresh groundwater which are the result of the large island landmasses causing orographic rainfall. The permeable soils and rocks that comprise the uplands allow easy infiltration of the abundant rainfall to accumulate as fresh groundwater. These geologic conditions allow for the subsurface movement of water with low-permeability geologic features impounding large amounts of water in the thick groundwater reservoirs.

The discussion of the hydrogeology includes a description of the four major aquifer types that occur in PHNC and other parts of O'ahu: (1) flank, volcanic basal aquifers; (2) dike-impounded, high-level aquifers; (3) perched, high-level aquifers; and (4) sedimentary basal aquifers.

1. Flank Volcanic Basal Aquifers

Flank volcanic basal aquifers are comprised of thousands of thin-bedded (10 ft [3.2m] or less), gently sloping (3 to 10 degrees), extrusive basaltic lava flows that comprise the bulk of the islands, including O'ahu. The structural features associated with these flows, such as an abundance of clinker sections, voids between flow surfaces, shrinkage joints, fractures, lava tubes, and gas vesicles make these rocks porous and highly permeable, thus ideal aquifers (Juvik *et al.* 1998). Hydraulic properties of the volcanic rock aquifers are determined by the distinctive textures and shape of individual lava flows. Individual lava flows commonly are highly permeable. The stratified nature of lava flows imparts a layered heterogeneity or diversity. Averaged over several lava-flow thicknesses, lateral hydraulic conductivity of dike-free lava flows is about 500 to 5,000 ft (152 to 457 m) per day, with smaller and larger values not uncommon. Systematic areal variations in lava-flow thickness or other properties may impart trends in the heterogeneity.

Because the flanks are the most regionally extensive volcanic formations, basal water is the most abundant form of groundwater on O'ahu. The height of the basal water table above sea level is called the head. Because of the density difference between fresh and salt water, about 40 ft (13 m) of freshwater is present below sea level for every foot of freshwater above sea level. That is, the lens thickness below sea level is equal to 40 times the head. This is referred to as the Ghyben-Herzberg freshwater lens. A high basal head (more than 5 ft [1.6 m]) within 1 mi (1.6 km) of a coast results from the impedance of coastal discharge by a wedge of low-permeability sediments called caprock (Juvik *et al.* 1998). Throughout much of O'ahu, groundwater is generally present in unconfined conditions, although artesian conditions exist in locations where low-permeability marine silts and volcanic tuffs (caprock) overlie the aquifer. Water-bearing zones may occur above, below, and within the caprock unit.

2. Dike-impounded High-Level Aquifers

Dike-impounded high-level aquifers are comprised of volcanic dikes which occur in volcanic rift zones. The dikes are dense, poorly permeable, and nearly vertical sheets of basaltic rock which have intruded into the highly permeable extrusive basaltic lava flows. Measuring a few ft (~1 m) in thickness, these dikes are very important hydrogeologically as they restrict the flow of groundwater. Where dikes make up 10 percent or more of the total rock volume and cut into the permeable basalt flows to form water storage compartments, they are called dike complexes. These are generally located at higher elevations and impound rain-fed, percolating water. High-level groundwater saturates dike complexes in the rift zones. Groundwater accumulates between dikes until it either escapes through fractures or reaches the surface, where it discharges as springs (Juvik *et al.* 1998).

3. Perched High Level Aquifers

High-level groundwater also occurs as local zones of saturation in permeable rock underlain by less permeable formations, such as buried ash or soil layers. Called perched water, such resources are generally of much smaller volume than high-level water impounded by dikes, but they may be adequate for local needs (Juvik *et al.* 1998).

4. Sedimentary Basal Aquifers

Groundwater also saturates sediments on coastal plains, particularly layers of limestone. This water is not usually fresh enough for drinking, but it may be acceptable for irrigation. Alluvium in stream valleys also carries small amounts of groundwater (Juvik *et al.* 1998).

2.3 ORGANIZATION OF CHAPTERS 3 THROUGH 6

The standard organization for chapters three through eight is in two parts: (1) General Biotic Environment; and (2) Current Management of Natural Resources.

2.3.1 Program Elements

INRMP objectives were developed through consultation with Navy resource managers, SAIA Working Group Members (USFWS, NOAA Fisheries, and the SOH DLNR) and Navy and non-Navy stakeholders. Table 2-2 provides a summary of the five natural resource management areas typically addressed in INRMPs, their corresponding goals, and their programmatic objectives. Natural resources management goals and objectives address 18 program elements required by Navy INRMP Guidance (DON 2005b) and an additional program element pertaining to community outreach. They include: (1) Threatened and Endangered Species, Critical Habitat, and Species of Concern; (2) Wetlands; (3) Fish and Wildlife; (4) Forests; (5) Vegetation; (6) Coastal Marine; (7) Invasive Species; (8) Wildland Fire; (9) Land Management; (10) Floodplains; (11) Outdoor Recreation; (12) Bird-Aircraft Strike Hazards (BASH); (13) Law Enforcement; (14) Agricultural Outleasing; (15) Other Leases; (16) Migratory Birds; (17) Research Needs; (18) Use of GIS; and (19) Community Outreach. For each objective identified in Table 2-2, corresponding program element numbers (#) are identified.

Table 2-2: Natural Resource Management Areas, Goals, and Objectives

Resource Area	Definition	Goals
Land Management	Consists of actions conducted to support the continuation of the military mission while complying with the suite of laws governing protection of natural resources.	Continued management, maintenance, and enhancement of land with natural resource value and protection of wetland and watershed resources.

Programmatic Objectives:

1. Manage, maintain, and enhance land areas with natural resource value (#2, #3, #4, #5, #6, #9, #11, #17).
2. Preserve, protect, and enhance wetlands with emphasis on controlling alien species, including mangrove, and establishing and enhancing native species (#2, #7, #9, #10).
3. Preserve and improve native habitats and ecosystems (#1, #2, #3, #4, #5, #6, #9).
4. Control, eradicate, and prevent the establishment of alien species (#4, #5, #7).
5. Manage, maintain, and enhance nesting habitat of protected bird species (#1, #2, #3, #4, #5, #9, #12, #16).
6. Coordinate with the JBPHH IEPM and IRP managers for the ongoing Navy efforts to identify and clean-up existing pollutants in Pearl Harbor water and sediment (#6, #9).
7. Coordinate with the JBPHH IEPM and IRP managers to minimize human exposure to existing pollutants in Pearl Harbor water, sediment, and organisms (#1, #2, #3, #6, #9).
8. Coordinate with the JBPHH IEPM and IRP managers to continue to improve surface water quality by reducing point and non-point sources of pollution by encouraging soil stabilization and erosion controls to reduce sedimentation into Pearl Harbor and other surface waters (#2, #6, #9, #10).
9. Continue to protect and maintain mature and significant trees and landscapes (#4, #5, #9).
10. Integrate mangrove removal in an effort to provide protection for fishpond walls at Pearl Harbor (#7, #9).
11. Continue to implement grass and vegetation management within appropriate areas such as antenna fields at NRTF Lualualei and NCTAMSPAC Wahiawa (#1, #5, #9).
12. Monitor adjacent civilian development and encroachment that could threaten the Navy's mission or natural resources (#9, #15).
13. Limit encroachment that threatens the Navy's ability to accomplish its mission, comply with Anti-Terrorism/Force Protection (AT/FP) requirements, and protect natural resources (#9, #13, #15).
14. Protect threatened and endangered species associated with JBPHH lands and waters through management actions and cooperative, interagency projects (#1, #2, #3, #4, #5, #6, #7, #8, #9, #13, #16, #17, #18).
15. Bolster the existing education campaign to centralize and disseminate information about JBPHH's natural resources information (#1, #2, #3, #4, #6, #7, #16, #19).
16. Increase on-base and community-wide cooperation, participation, and awareness to supplement efforts to protect lands with natural resource value and habitat for threatened and endangered or otherwise protected species and essential habitat (#1, #2, #3, #4, #6, #7, #16, #19).
17. Actively participate in future land use and facility development decisions by providing input and advice regarding natural resources constraints, potentially significant impacts, and suggested mitigation measures (#9).

Table 2-2: Natural Resource Management Areas, Goals, and Objectives (Continued)

Resource Area	Definition	Goals
Fish and Wildlife Management	Consists of actions necessary to protect fish, wildlife, plants, and their habitats, with particular emphasis on threatened and endangered species and associated habitats, migratory birds, wetlands, coral reefs, and other federal trust resources.	Continued conservation, protection, and when feasible, enhancement of fish and wildlife resources, especially protected and sensitive species. Native plant and animal species take precedence over alien species. Pest species should be controlled to benefit not only humans but native species as well.
Programmatic Objectives: 1. Protect, conserve, and manage terrestrial and aquatic flora and fauna as vital elements of the natural resources program including fish, corals, Hawaiian monk seals, and sea turtles (#1, #3, #6, #9). 2. Proactively manage/monitor known threatened and endangered or otherwise protected species as required by law (#1). 3. Maintain baseline information on aquatic resources and fisheries at Pearl Harbor in order to facilitate effective resource management (#3, #6) 4. Monitor and track changes in the quality of the marine environment at Pearl Harbor over time (#6). 5. Protect threatened and endangered or otherwise protected marine species that may occur in waters adjacent to Pearl Harbor (#1, #3, #6). 6. Prevent the introduction of new non-indigenous, aquatic species into Pearl Harbor and surface waters to avoid detrimental impacts to the harbor ecosystem (#7). 7. Continue to comply with the provisions of the Cooperative Agreement for the Protection, Development, and Management of Wildlife Resources at JBPHH, executed between the Navy, USFWS, NOAA Fisheries, and DLNR (#1, #3, #6). 8. Within Pearl Harbor, work to improve water quality and reduce contaminant levels to improve the health of the marine ecosystem and to enable possible future consumptive uses (#3, #6, #9, #10).		
Forestry Management	Consists of actions to exercise best management practices (BMPs) to develop and maintain a biological balance in the forest community consistent with proven scientific practices to provide for wildlife habitat, watershed protection, and recreation opportunities.	The primary goal for forestry management at JBPHH is to exercise BMPs protect the remaining forested areas and mature and significant trees and landscapes.
Programmatic Objectives: 1. Protect forested areas to provide watershed protection and prevent soil erosion (#4, #5, #8, #9, #10). 2. Restore and enhance native tree and plant populations with plantings when feasible (#4, #5, #9). 3. Identify, preserve, and protect stands of mature trees and/or landscapes that are considered significant or exceptional (#4, #5, #9). 4. Wherever possible, utilize forest areas for hiking, bird watching, interpretive nature trails, picnicking, and other multiple uses compatible with the installation mission (#11). 5. Identify, protect, and preserve areas that support rare and protected species (#1, #3, #4, #5).		
Agricultural Outlease	Consists of actions to provide agricultural outleases of suitable and available land.	Continued agricultural outleasing and promoting such outleases for underutilized Navy lands that are suitable for grazing and farming.
Programmatic Objectives: 1. Continue agricultural outleasing of underutilized Navy lands to generate revenue and minimize land maintenance costs, provided it does not conflict with security (#14)		

Table 2-2: Natural Resource Management Areas, Goals, and Objectives (Continued)

Resource Area	Definition	Goals
Outdoor Recreation	Consists of activities that are fish and wildlife-oriented. Other outdoor recreation activities that are facilities oriented (e.g., recreation cabins, outdoor recreation fields, swimming facilities) are not actions normally included in INRMPs.	Military personnel, their dependents, and the public, in general, continued opportunities for participation in outdoor recreation activities that capitalize on natural resources. These activities, however, should be controlled and monitored when they interfere with natural resource management objectives and goals
Programmatic Objectives: 1. Continue and, when possible, expand public opportunities for natural resource-related outdoor recreation where it does not conflict with public health and safety, the military mission, or security (#11). 2. Ensure that recreational use and enjoyment of natural resources does not compromise public health or safety (#11). 3. Ensure that the degree of access allowed for outdoor recreation is consistent with conservation of natural resources (#1, #3, #11). 4. Promote awareness of natural resources, the importance of resource stewardship, and a sense of pride in the natural environment of the JBPHH (#19). 5. Protect, restore, and enhance important natural and cultural assets (e.g. fishponds) in the JBPHH for public benefit and enjoyment (#11, #19). 6. Mediate conflicts between competing outdoor recreational uses (#11).		

2.3.2 Current Management Actions

Sections 3.4, 4.4, 5.4, and 6.4 provide discussions of the Navy's current management actions at PHNC, Lualualei, NCTAMSPAC Wahiawa, and Kalaeloa, respectively. Note that Chapter 7 (Hickam Insert) does not follow the same format as the other JBPHH study areas. The program elements are incorporated in the management actions which are listed below.

1. Protected Species and Ecosystem Monitoring and Management;
2. Natural Resources Studies;
3. GIS;
4. Forestry;
5. Community Outreach;
6. Outdoor Recreation;
7. Land Management;
8. Flood Plains;
9. Law Enforcement;
10. Wildland Fire; and
11. Leases and Encroachment

2.4 GIS MANAGEMENT, DATA INTEGRATION, ACCESS, AND REPORTING

As the installation's natural resources are surveyed and updated, NAVFAC PAC Natural Resource staff has been grouping land uses and constraints by location. This compilation of physical information is captured, stored, updated, manipulated, displayed, and analyzed in a GIS database. The natural resources data is integrated into the Region's GIS system and made available to planners and land managers to aid in decision-making. When combined with operational and infrastructure information, natural resource GIS provides installation commanders and public works officers the situational awareness information needed to make sound decisions. Integration of natural resources data into the GIS database ensures that the installation is not using conflicting resource management techniques or planning land uses that conflict with natural resources preservation or the installation's mission.

The JBPHH IEPM and NAVFAC PAC Natural Resource staff ensures that newly acquired or updated natural resources information is integrated into the installation GIS database on a regular basis. NAVFAC HI maintains GIS layers in geodatabase format for PHNC, Lualualei, NCTAMSPAC and Kalaeloa for the following data: (1) fauna habitat; (2) fauna special species areas; (3) wildlife management areas; (4) flora special species areas; and (5) land vegetation cover. That information has been used to generate maps for this INRMP.

CHAPTER 3

PEARL HARBOR NAVAL COMPLEX

CHAPTER THREE: PEARL HARBOR NAVAL COMPLEX

Photo 3-1: View of Shipyard area of PHNC from Ford Island

3.1 CURRENT CONDITIONS AND USE

3.1.1 Installation Information

PHNC (Photo 3-1) is centered primarily on the Pearl Harbor estuary, south-central coast of O‘ahu, State of Hawai‘i. PHNC is comprised of approximately 10,234 ac (4,142 ha) of land, approximately 68,081 ac (27,552 ha) of water, and 36 mi (58 km) of shoreline (Figure 3-1).

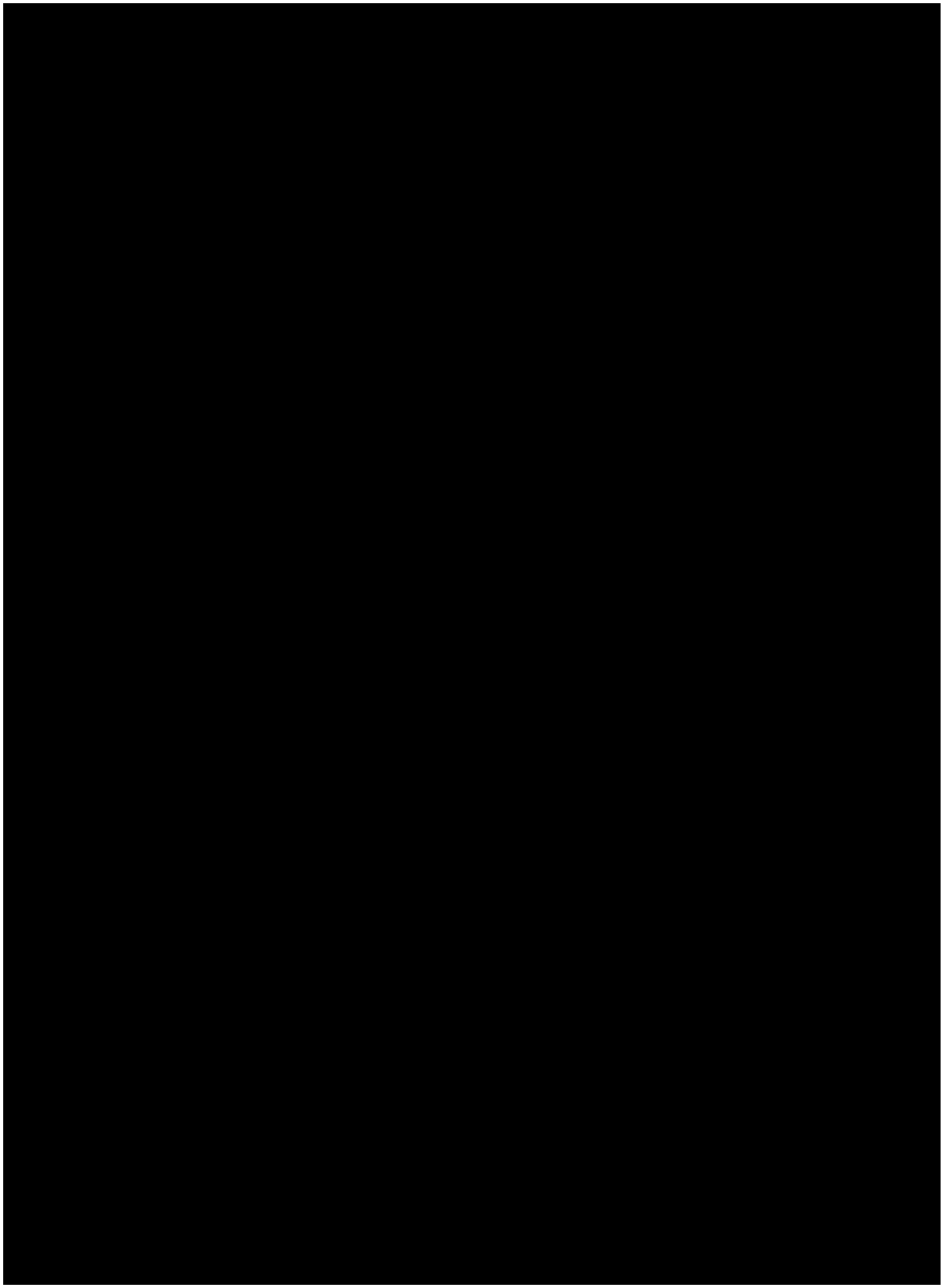
3.1.1.1 General Description

PHNC is one of the nation’s most strategic naval installations. CNRH utilizes PHNC to conduct its most important mission, coordinating the Navy’s local support of the COMPACFLT. Since the beginning of the 20th century, PHNC has been the Navy’s primary installation in the Pacific. It provides logistic support including ship berthing, repair and maintenance, supply and storage, and public works support to the Navy operating forces in the region (CNRH 2006).

3.1.1.2 Land Use Constraints

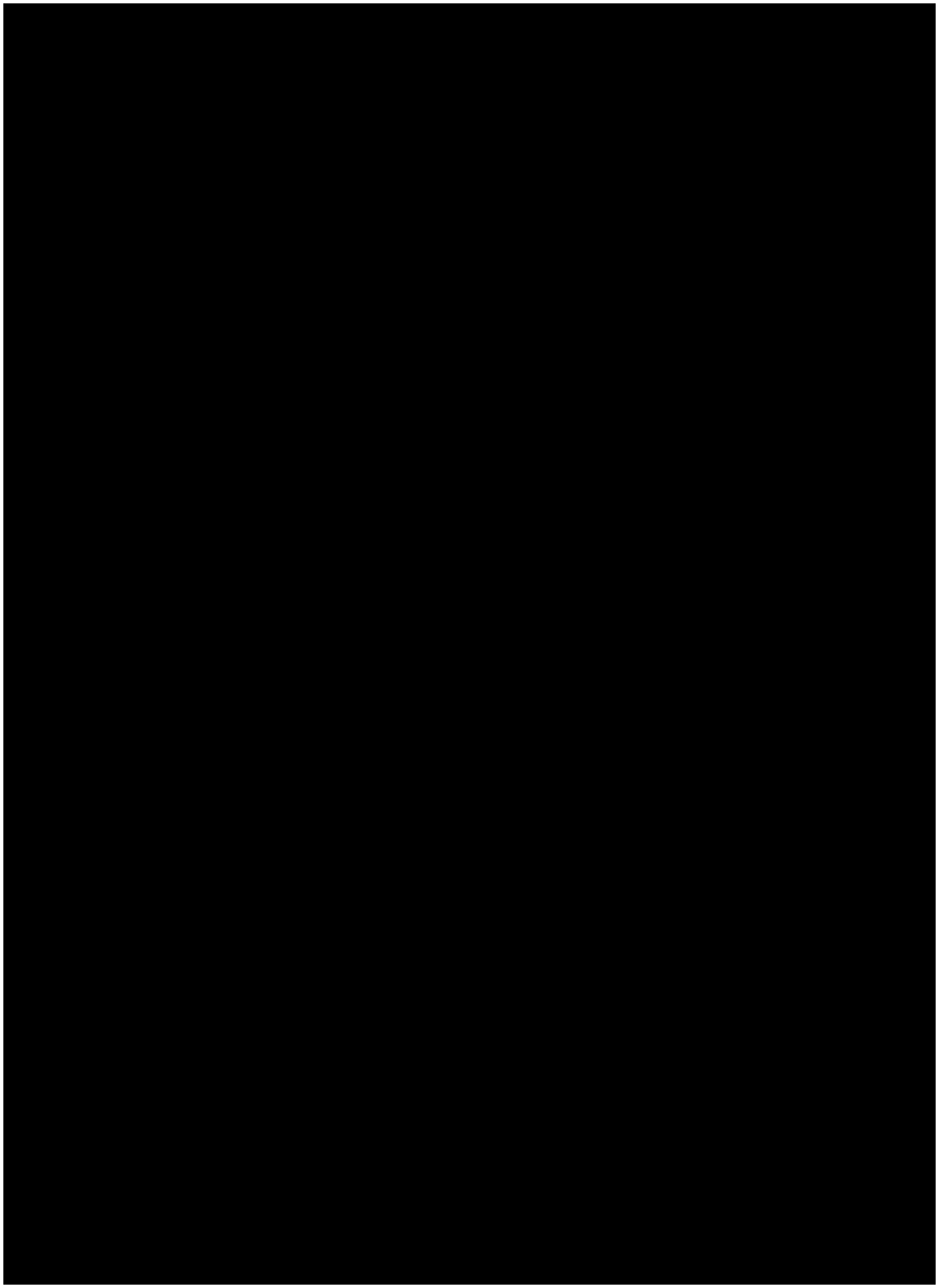
The environmental land use constraints at PHNC are defined by the presence of ESA- and MBTA-protected species and sensitive habitat including the harbor, Pearl Harbor National Wildlife Refuge (PHNWR) Honouliuli and Waiawa Units, wetlands, and historic fishponds (Figure 3-2). Section 3.3 presents a description of the protected species and habitats located at PHNC.

The following paragraphs describe the military land use constraints at PHNC. Because the main purpose of PHNC is to fulfill CNRH’s mission of providing local support to COMPACFLT, most of the land area within PHNC is developed, and, unlike many Navy installations, only a limited portion of PHNC is used for specialized military training. CNRH and its tenant commands use the majority of the land areas for administration and support services, family housing, or recreation. Most of the operational facilities are consolidated in the highly



Redaction:Defense Critical Security Information Statute 10 U.S.C. § 130e

Figure 3-1: PHNC Study Area



Redaction:Defense Critical Security Information Statute 10 U.S.C. § 130e

Figure 3-2: Constraints, PHNC Study Area

developed core fronting Southeast Loch; other land areas around the harbor are used for supply, recreation, family housing, or other operations (Figures 3-3 and 3-4).

In addition, NAVMAG PH West Loch Branch, located on the southwest side of Pearl Harbor, contains magazines, operations, and maintenance buildings, community and personnel support facilities, and wharves for loading and off-loading of military ordnance (Figure 3-3). Consistent with its mission, NAVMAG PH ammunition storage and ordnance operations require that large areas of land be set aside for ESQD arcs (Figure 3-2). The lands within the arcs contain undeveloped lands that are used by a variety of protected bird species, contain USACE-defined and USFWS-defined wetlands, and land used or suitable for agricultural purposes.

3.1.1.3 Land Use Opportunities

No new military mission training land use opportunities were identified at PHNC.

3.1.1.4 Operations and Activities

Figures 3-3 and 3-4 show the operations areas for the western and eastern portions of PHNC, respectively. Most of the operational facilities are consolidated in the highly developed core fronting Southeast Loch; other land areas around the harbor are used for supply, recreation, family housing, or other operations. For the purposes of this INRMP, PHNC has three natural resources land use categories: (1) areas of significant natural resource value; (2) highly developed or industrialized areas with limited natural resource value; and (3) family housing communities with limited natural resource value. These areas are described in Table 3-1.

1. Areas with Significant Natural Resource Value

There are six general land/water areas within PHNC, totaling approximately 75,063 ac (30,377 ha), which have significant natural resource value: (1) intertidal and coastal land areas and waters of Pearl Harbor, the NDSA, and off shore training areas (Figure 2-2); (2) undeveloped areas of Makalapa Crater; (3) undeveloped areas of Pearl City Peninsula including the Waiawa Unit of the PHNWR; (4) undeveloped areas of Red Hill Storage Area; (5) the Waiawa Watershed; (6) NAVMAG PH West Loch Branch including most of Waipi'o Peninsula and the Honouliuli Unit of the PHNWR. These areas are shown Figure 3-5 and described in Table 3-1.

2. Highly Developed and Industrialized Areas

As shown in Figure 3-6, there are 15 highly developed and industrialized areas within PHNC, totaling approximately 1,953 ac (790 ha), which have limited natural resource value: (1) Beckoning Point; (2) Bishop Point; (3) FFD; (4) Ford Island; (5) Fort Kamehameha WWTP; (6) MSC/NEX/ Commissary; (7) NISMO; (8) Naval Station; (9) developed portions of NAVMAG PH West Loch; (10) Navy-Marine Golf Course; (11) Ohana Nui; (12) Public Works Center Compound; (13) Richardson Recreation Center; (14) Salt Lake Storage Area; and (15) the Shipyard. Table 3-1 provides a general description of these areas.

Table 3-1: PHNC Lands and Waters

Site	Approximate Land Area in ac (ha)	Tax Map Key Number	Types of Operations	Requires a Natural Resources Management Plan
Land Use Category: Areas with Significant Natural Resource Value				
Intertidal and Coastal Land Areas and Waters of Pearl Harbor, the NDSA, and off shore training areas (Figure 2-2)	Approximately 68,081 ac (27,552 ha) of open water area, approximately 368 ac (149 ha) of intertidal waters (up to the high tide mark and the lower reaches of the streams entering the harbor); and approximately, 36 mi (58 km) of shoreline. Approximately 403 ac (163 ha) of other coastal lands.	NA	Ship berthing, repairs, ship deactivation storage, operations, training, security, recreation	Yes. Includes PHNWR Honouliuli and Waiawa Units; federally- and SOH-listed waterbirds, marine mammals, and sea turtles; MBTA-protected bird species, chemically-impacted sediments and fish species in the harbor; USACE-jurisdictional and USFWS-defined wetlands; outdoor recreation areas; cultural resources including fishponds, and is included in the Pearl Harbor National Historic Landmark (NHL).
Makalapa Crater	Approximately 180 ac (73 ha) including administration buildings, active and passive recreation, and a housing community.	Portion 9-9-002: 004	COMPACFLT headquarters, administration and housing community	Yes. Includes vegetated crater interior which attracts protected bird species and contains mature and significant trees.
Pearl City Peninsula	Contains approximately 644 ac (269 ha).	9-6-001: 001, 008; 9-7-001: 001; 9-7-005: 002, 003, 014; 9-7-006: 001, 002, 015; 9-7-007: 001, 014, 020; 9-7-008: 001; 9-7-009: 002; 9-7-010: 001; 9-7-011: 001, 003; 9-7-012: 002; 9-7-013: 001; 9-7-014: 001; 9-7-015: 002; 9-7-016: 001; 9-7-027: 001	Partially developed with buildings and structures; a family housing community; and paved roadways, driveways, and parking lots	Yes. PHNWR Waiawa Unit, as well as other wetlands, is located here. These wetlands attract federally-and SOH-listed bird species and MBTA-protected birds. Mature trees are also present.

Table 3-1: PHNC Lands and Waters (Continued)

Site	Approximate Land Area in ac (ha)	Tax Map Key Number	Types of Operations	Requires a Natural Resources Management Plan
Red Hill Storage Area	78 ac (31.5 ha)	9-9-010: 006; 1-1-012: 004	Located on the ridge of Red Hill, between the Hālawa and Moanalua Valleys, just west of the Moanalua Golf Course, this area is operated by FISC and contains 20 fuel underground storage tanks; a tunnel; a water production well; a small arms firing range; buildings; and paved roadways, driveways, and parking lots.	Yes. This area contains vegetated regions that attract MBTA-protected bird species. A Navy-owned potable water supply well is located here. There are areas of limited soil erosion along the ridgeline. Mature trees are located here.
Waiawa Watershed	75 ac (30 ha)	9-6-004: 008	Located about 2 mi (3.2 km) north (upland) of the Naval Station, in the lower reaches of Waiawa Valley. This is the site of NAVFAC HI's Waiawa Shaft Pumping Facility, CNRH's largest source of potable water.	Yes. This area includes vegetated areas that attract MBTA-protected birds, streams, a Navy-owned potable water supply well, portions of the Waiawa and Waimano Streams, and contains mature trees.
NAVMAG PH West Loch Branch (including Waipi'o Peninsula)	5,234 ac (2,233 ha) in total with West Loch comprising 4,092 ac (1,662 ha) and Waipi'o Peninsula comprising 1,412 ac (571 ac)	9-1-010: 001, 014, 015, 016 (West Loch) and 9-3-002: 001 (Waipi'o Peninsula)	Contains magazines, operations and maintenance buildings, community and personnel support, wharves for loading and unloading of explosives and other military ordnance and materiel, and open lands within the established ESQD arcs.	Yes. Contains PHNWR Honouliuli Unit, federally-listed and MBTA protected bird species, land suitable for agricultural outlease, undeveloped lands, and mature trees.
Land Use Category: Highly Developed and Industrialized Areas with Limited Natural Resource Value				
Beckoning Point		Portion 9-3-002: 001	This area is part of the Naval Station and includes an active degaussing station, an inactive boat painting and repair facility as well as paved and unpaved roadways and parking areas.	Yes. A small mangrove wetland is located here. The site also contains other mature trees. The site lies along the Middle Loch/Ford Island Channel shoreline.
Bishop Point	16 ac (7 ha)	Portion 9-9-001: 013	Tenants include Mobile Diving Salvage Unit (MDSU) 1 and the Emergency Ship Salvage Material (ESSM) detachment. The site is highly developed and includes buildings, structures, paved driveways, and parking areas.	Yes. The site is located immediately adjacent to PHEC and Māmala Bay.

Table 3-1: PHNC Lands and Waters (Continued)

Site	Approximate Land Area in ac (ha)	Tax Map Key Number	Types of Operations	Requires a Natural Resources Management Plan
FFD	9 ac (4 ha)	Portion 9-9-002: 004	Located at the corner of Kamehameha Highway and Center Drive, this area is developed and includes buildings, paved driveways and parking lots, and limited landscaped areas.	Yes. This site may contain mature trees.
Ford Island	451 ac (183 ha)	9-9-001: 015	Developed and industrialized land including buildings; paved roadways, driveways, and parking lots; some open and landscaped areas, particularly around the family housing communities.	Yes. Surrounded by the waters of Pearl Harbor and includes mature and significant landscaped areas and trees.
Fort Kamehameha WWTP	14 ac (6 ha)	Portion 9-9-001: 013	NAVFAC HI operates this WWTP which is a highly developed area with buildings, paved roadways, driveways, and parking lots.	Yes. This site is located immediately adjacent to PHEC and Māmala Bay, and contains an ocean outfall.
MSC/NEX/Commissary	79 ac (32 ha)	1-1-010: 011 and 022	Highly developed with a new shopping center; paved roadways, driveways, parking lots; and limited landscaped areas. Tenants include MWR and Defense Commissary Agency (DECA).	Yes. This site contains mature trees.
NISMO	3 ac (1 ha)	Portion 9-3-002: 001	Highly developed shoreside facility including 10 buildings.	Yes. This site is located immediately adjacent to the inactive ship berths in Middle Loch.
Naval Station	595 ac (241 ha)	9-9-001: 008	Highly developed and industrialized lands including 432 ac (175 ha) under the jurisdiction of FISC; 123 ac (50 ha) under the jurisdiction of Submarine Base (SUBASE); and 40 ac (16 ha) under the jurisdiction of Naval Station.	Yes. This site contains mature and significant landscapes and trees and is located immediately adjacent to industrialized waterfront of Southeast Loch.
Navy-Marine Golf Course	156 ac (63 ha)	Portion 1-1-010: 004	This site includes manicured and landscaped grounds with buildings, including a clubhouse facility; and paved pathways and driveways.	Yes. This site contains mature trees and open space which provides visual relief from urban landscape.

Table 3-1: PHNC Lands and Waters (Continued)

Site	Approximate Land Area in ac (ha)	Tax Map Key Number	Types of Operations	Requires a Natural Resources Management Plan
Ohana Nui	45 ac (18 ha)	Portion 1-1-002: 004	This site contains developed lands including churches; private schools; ball fields; paved roadways, driveways, and parking lots; and limited landscaped areas.	Yes. This site contains mature trees.
Public Works Center Compound	71 ac (29 ha)	Portion 1-1-010: 011	NAVFAC HI operates this site which contains highly developed and industrialized land; paved roadways, driveways, and parking lots; and limited landscaped areas.	Yes. This site contains mature trees.
Richardson Recreation Center and Aiea Landing	59 ac (24 ha)	9-9-003: 029, 030	Tenants include MWR and National Park Service. Developed recreation and marina facilities including 26 buildings; paved roadways, driveways, and parking lots, and open landscaped areas.	Yes. This site is adjacent to the waters of Aiea Bay and East Loch, contains open space which provides a view plane to Pearl Harbor, and contains mature trees.
Salt Lake Storage Area	10 ac (4 ha)	Portion 1-1-010: 004	Operated by Forest City Military Communities, LLC (FCMC) which manages family housing for the Navy, this site contains developed lands including historic warehouses, parking lots, driveways, and limited landscaped areas.	Yes. This site contains mature trees.
Naval Shipyard (Shipyard)	445 ac (180 ha)	Portion 9-9-001: 008	Tenants include Naval Shipyard, Naval Station, and NAVFAC HI. Highly developed and industrialized lands including buildings; paved roadways, driveways, and parking lots, and limited landscaped areas which are largely restricted to the Hale Alii, Hospital Point, and Marine Barracks Housing Communities. The Naval Shipyard comprises 299 ac (121 ha); the former Naval Station property totals 64 ac (26 ha), and the remaining 82 ac (33 ha) include NAVFAC HI utilities facilities and housing areas.	Yes. This site is located adjacent to Southeast Loch and the main channel of Pearl Harbor and it contains mature and significant trees and landscapes.

Table 3-1: PHNC Lands and Waters (Continued)

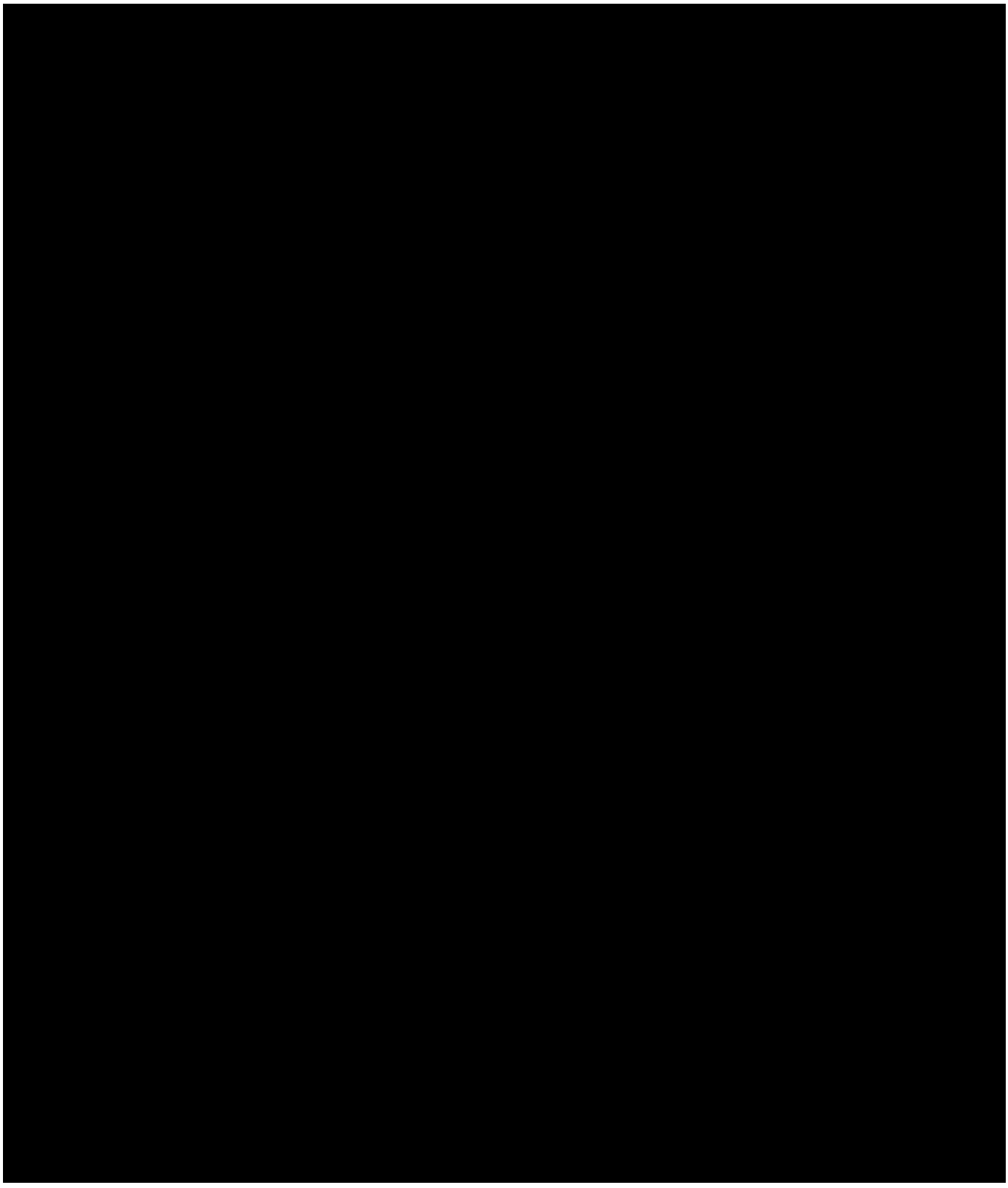
Site	Approximate Land Area in ac (ha)	Tax Map Key Number	Types of Operations	Requires a Natural Resources Management Plan
Land Use Category: Family Housing Communities with Limited Natural Resource Value				
Catlin Park Housing Community	84 ac (34 ha)	Portion 1-1-010: 004	Managed by FCMC which redeveloped the area to include 319 new family housing units (FHU) and associated amenities including landscaped areas.	Yes. This site contains mature trees.
Doris Miller Park Housing Community	35 ac (14 ha)	Portion 1-1-010: 004	Managed by FCMC which operates/maintains 214 FHU and associated amenities including landscaped areas.	Yes. This site contains mature trees.
Ford Island Housing Community	35 ac (new) acres	Portion 9-9-001: 015	Contains three existing housing areas operated by FCMC: (1) Luke Field – 20 historic FHU; (2) Nob Hill – 20 historic FHU; and (3) Kamehameha Loop - 140 recently constructed FHU.	Yes. These sites contain mature and significant landscapes and trees. Some of the housing areas are located adjacent to the waters of Pearl Harbor.
Halawa Housing Community	22 ac (9 ha)	9-9-010: 014	Managed by FCMC which operates/maintains 96 FHU and associated amenities including landscaped areas.	Yes. This site contains a Navy-owned potable water supply well and contains mature trees.
Hale Alii Housing Community	26 ac (11 ha)	Portion 9-9-001: 008	Managed by FCMC which operates/maintains 14 FHU and associated amenities including landscaped areas.	Yes. This site contains mature and significant landscapes and trees.
Hale Moku Housing Community	69 ac (27 ha)	Portion of 9-9-001: 008; portion of 1-1-010: 003	Managed by FCMC which operates/maintains 318 FHU and associated amenities including landscaped areas.	Yes. This site contains mature trees.
Halsey Terrace Housing Community	120 ac (49 ha)	Portion of 1-1-010: 004	FCMC operates/maintains 477 new FHU and associated amenities including landscaped areas.	Yes. This site contains mature trees.
Hokulani Housing Community	40 ac (16 ha)	Portion of 1-1-010: 003	Managed by FCMC which operates/maintains 190 FHU and associated amenities including landscaped areas.	Yes. This site contains mature trees.

Table 3-1: PHNC Lands and Waters (Continued)

Site	Approximate Land Area in ac (ha)	Tax Map Key Number	Types of Operations	Requires a Natural Resources Management Plan
Hospital Point Housing Community	19 ac (8 ha)	Portion 9-9-001: 008	Managed by FCMC which operates/maintains 19 FHU and associated amenities including landscaped areas.	Yes. This site contains mature and significant landscapes and trees and is located immediately adjacent to the waters of Pearl Harbor.
Little Makalapa Housing Community	4 ac (2 ha)	9-9-002: 004	This site includes 30 FHU and associated amenities including landscaped areas. Land use changed from Navy family housing to another Navy use.	Yes. This site contains mature trees.
Makalapa Housing Community	51 ac (21 ha)	9-9-002: 004	Managed by FCMC which operates/maintains 107 FHU and associated amenities including landscaped areas.	Yes. This site contains mature and significant landscapes and trees.
Maloelap Housing Community	14 ac (6 ha)	Portion of 1-1-010: 004	Managed by FCMC which operates/maintains 23 FHU (1 historic and 22 under construction) and associated amenities including landscaped areas.	Yes. This site contains mature trees.
Manana Housing Community	23 ac (9 ha)	9-9-001: 008	Managed by FCMC which operates/maintains two historic FHU and associated amenities including landscaped areas.	Yes. This site contains mature trees.
Marine Barracks Housing Community	50 ac (20 ha)	Portion of 9-9-001: 008	Managed by FCMC which operates/maintains 11 historic FHU and associated amenities including landscaped areas.	Yes. This site contains mature and significant landscapes and trees.
McGrew Point Housing Community	49 ac (20 ha)	9-8-019: 003	Managed by FCMC which operates/maintains 131 new FHU and associated amenities including landscaped areas.	Yes. This site contains the Pa'aiau Fishpond, a USACE-defined jurisdictional wetland and National Register of Historic Places (NRHP)-eligible fishpond. It is located immediately adjacent to the waters of Pearl Harbor and contains mature trees.
Moanalua Terrace Housing Community	116 ac (47 ha)	1-1-010: 011 (portion), 012	Managed by FCMC which operates/maintains 752 FHU and associated amenities including landscaped areas.	Yes. This site may contain mature trees.

Table 3-1: PHNC Lands and Waters (Continued)

Site	Approximate Land Area in ac (ha)	Tax Map Key Number	Types of Operations	Requires a Natural Resources Management Plan
Pearl City Peninsula Housing Community	535 ac (217 ha)	9-9-001: 008	Managed by FCMC which operates/maintains 635 FHU and associated amenities including landscaped areas.	Yes. Portions of this site are located immediately adjacent to the waters of Pearl Harbor. This site contains open space and contains mature trees.
Red Hill Housing Community	7 ac (3 ha)	9-9-010: 050 (portion)	Managed by FCMC which will demolish all 10 FHU and associated amenities including landscaped areas.	Yes. This site contains mature trees.



Redaction:Defense Critical Security Information Statute 10 U.S.C. § 130e

Figure 3-3: Land Use, PHNC Study Area (Western Portion)

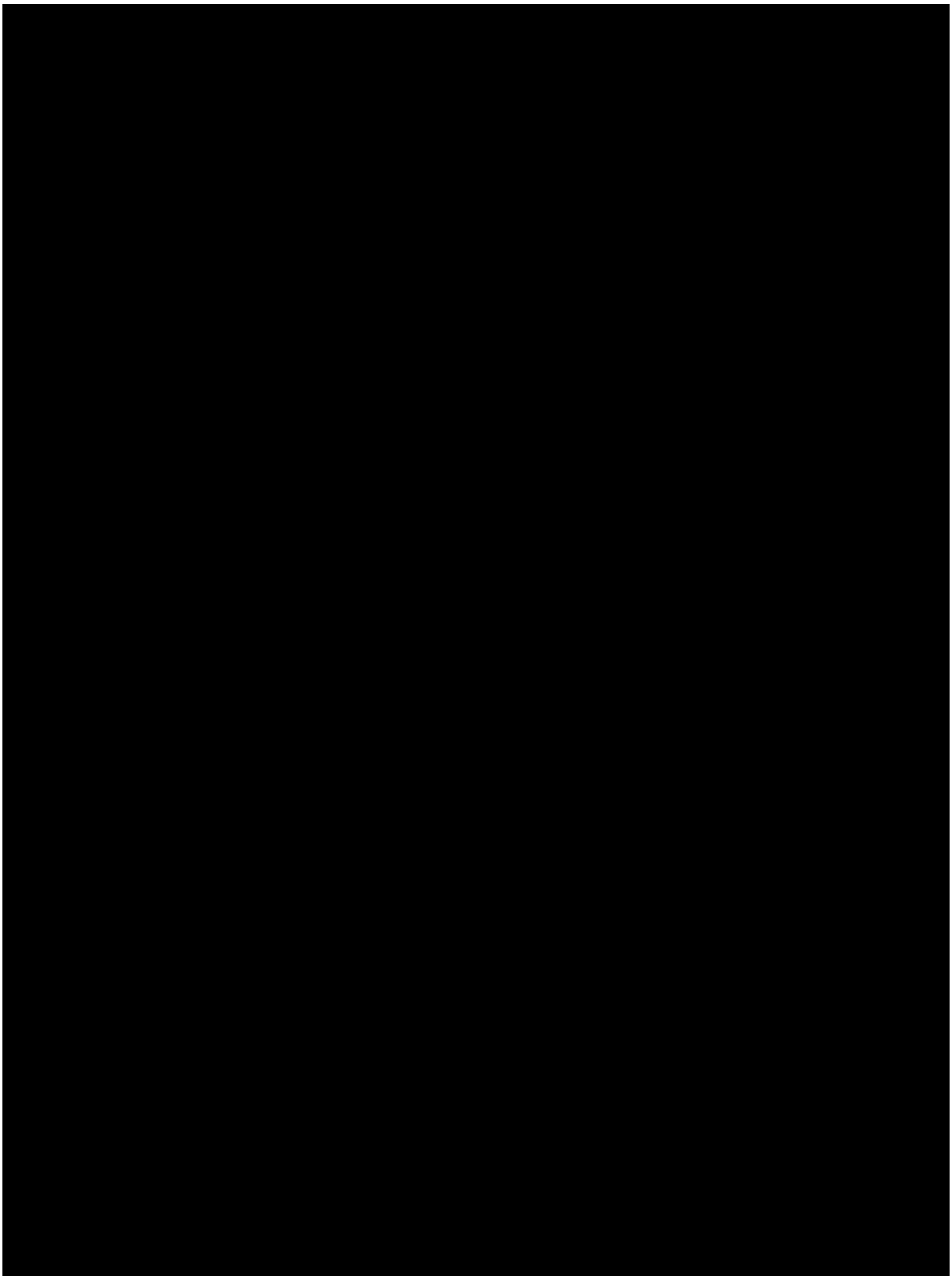


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Figure 3-4: Land Use, PHNC Study Area (Eastern and Outlying Portions)

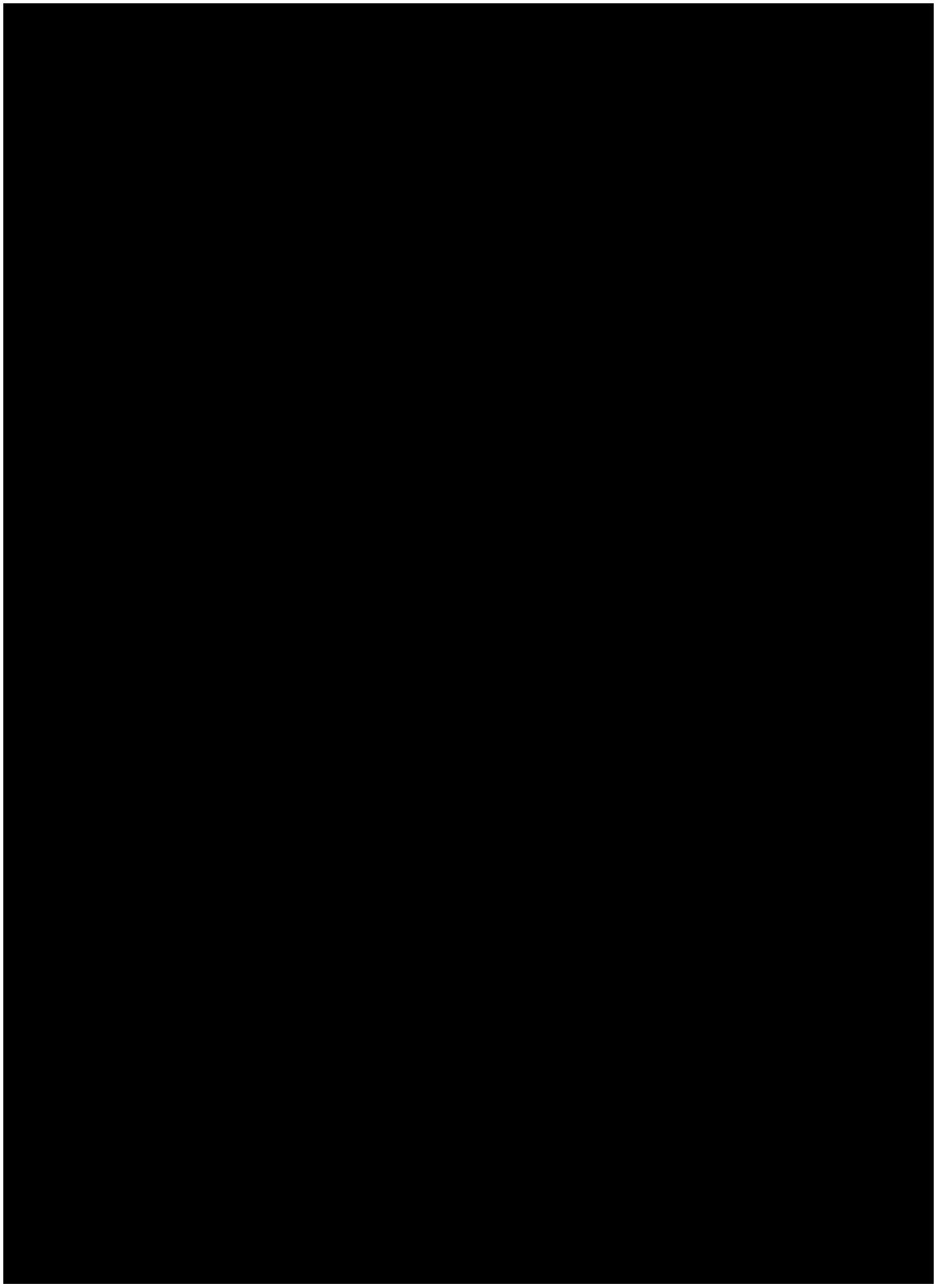

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Figure 3-5: Areas with Significant Natural Resource Value, PHNC Study Area

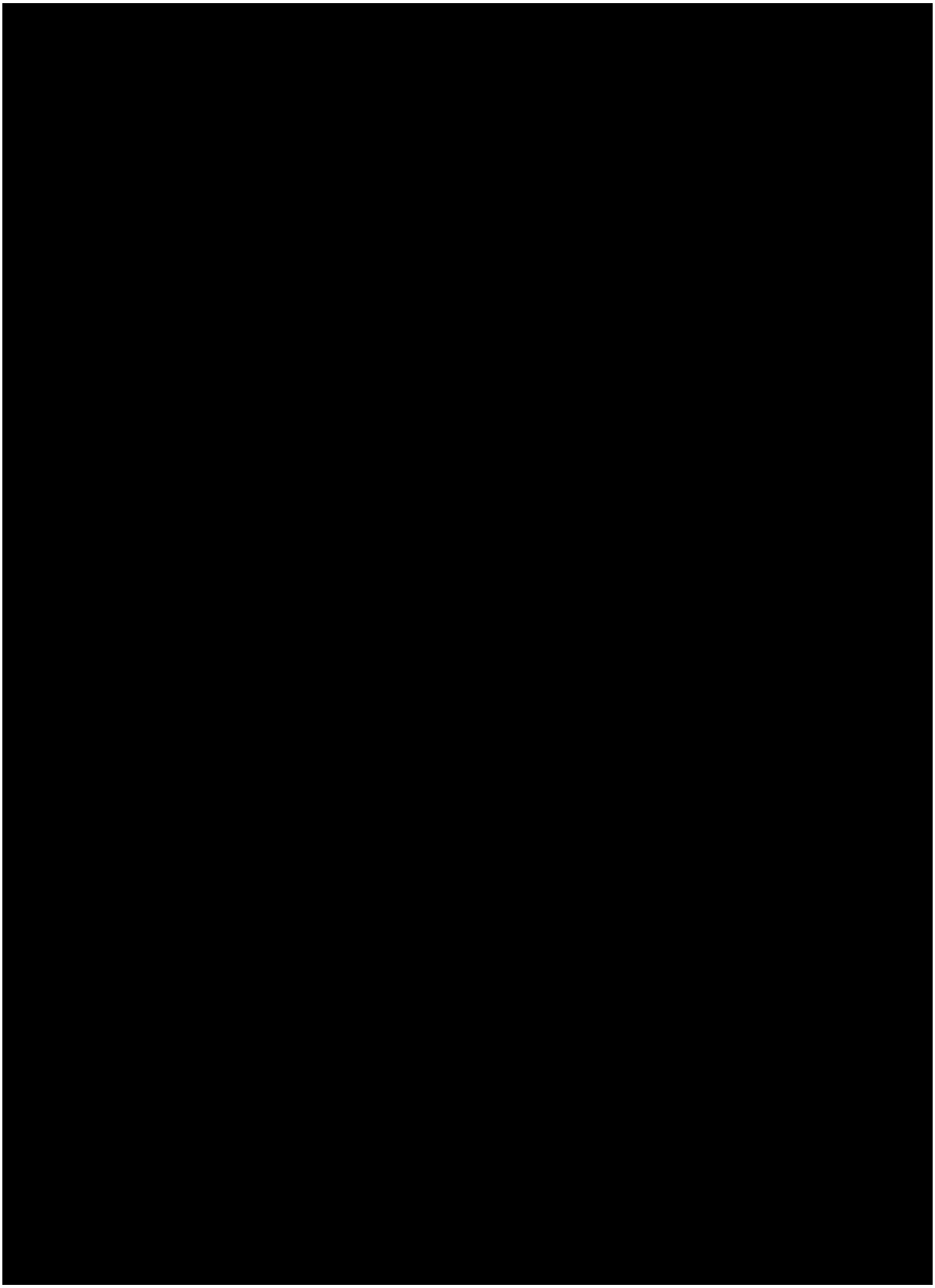

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Figure 3-6: Highly Developed and Industrialized Areas, PHNC Study Area

3. Navy Family Housing Communities

As shown in Figure 3-7, there are 19 Navy family housing communities totaling 1,299 ac (526 ha) within the PHNC managed by FCMC that contain significant and/or mature trees and/or landscapes and may offer passive outdoor recreation areas: (1) Catlin Park; (2) Doris Miller Park; (3) Ford Island; (4) Hālawa; (5) Hale Alii; (6) Hale Moku; (7) Halsey Terrace; (8) Hokulani; (9) Hospital Point; (10) Little Makalapa; (11) Makalapa; (12) Maloelap; (13) Mānana; (14) Marine Barracks; (15) McGrew Point; (16) Moanalua Terrace; (17) Pearl City Peninsula; (18) Radford Terrace; and (19) Red Hill. Table 3-1 provides a general description of the PHNC housing communities.

3.1.1.5 Abbreviated History and Pre-Military Land Use

Prior to the 20th century, Native Hawaiians utilized the wetland areas around Pearl Harbor for subsistence activities such as fishponds and taro cultivation. Water quality was reportedly high and sedimentation and turbidity was low. It is estimated that at one time there were 26 inland and coastal Hawaiian fishponds comprising 564 ac (228 ha) in operation in the Pearl Harbor area (Hawai'i Department of Agriculture 1999 in DON 2001a). Hawaiians also constructed agricultural features such as wetland pond systems for taro cultivation. Spring fed areas such as those found at Kalauao, Waimalu, and Waiau were used for taro production.

Maintaining the agricultural and aquacultural features in and around Pearl Harbor required significant manpower; the Native Hawaiian traditional hierarchy of chiefs and stewards controlled the land and commoners provided the labor. The Great Mahele of 1848 altered land ownership patterns in Hawai'i and distributed lands in fee to smaller owners. It was more difficult for the landowners to maintain the large fishponds and keep taro lands in production. Most of the fishponds became the property of the Hawaiian government, and some of the agricultural features fell into disuse. The assimilation of western and eastern diets led to a lower demand for taro, and some farmers converted taro lands into rice production. This conversion to rice farming occurred at Pearl City Peninsula in the late 1800s (USACE 1999).

In 1877, King Kalākaua gave the U.S. the exclusive rights to enter Pearl Harbor to establish a coaling station for Navy vessels (eventually constructed within the western portion of the Shipyard), and to improve the entrance to the harbor. Prior to the construction of PHEC, the harbor was more restricted from the open ocean by a sandy barrier at the entrance.

In 1893, the Hawaiian Monarchy was overthrown and, in 1896, the U.S. government annexed Hawai'i. The U.S. government began condemnation proceedings in 1901 so that the U.S. could acquire land for a naval station around Pearl Harbor. The Pearl Harbor shore establishment was created in 1901 with the FISC at what is now Kūāhua Peninsula, and a strip on the southeast side of Ford Island.

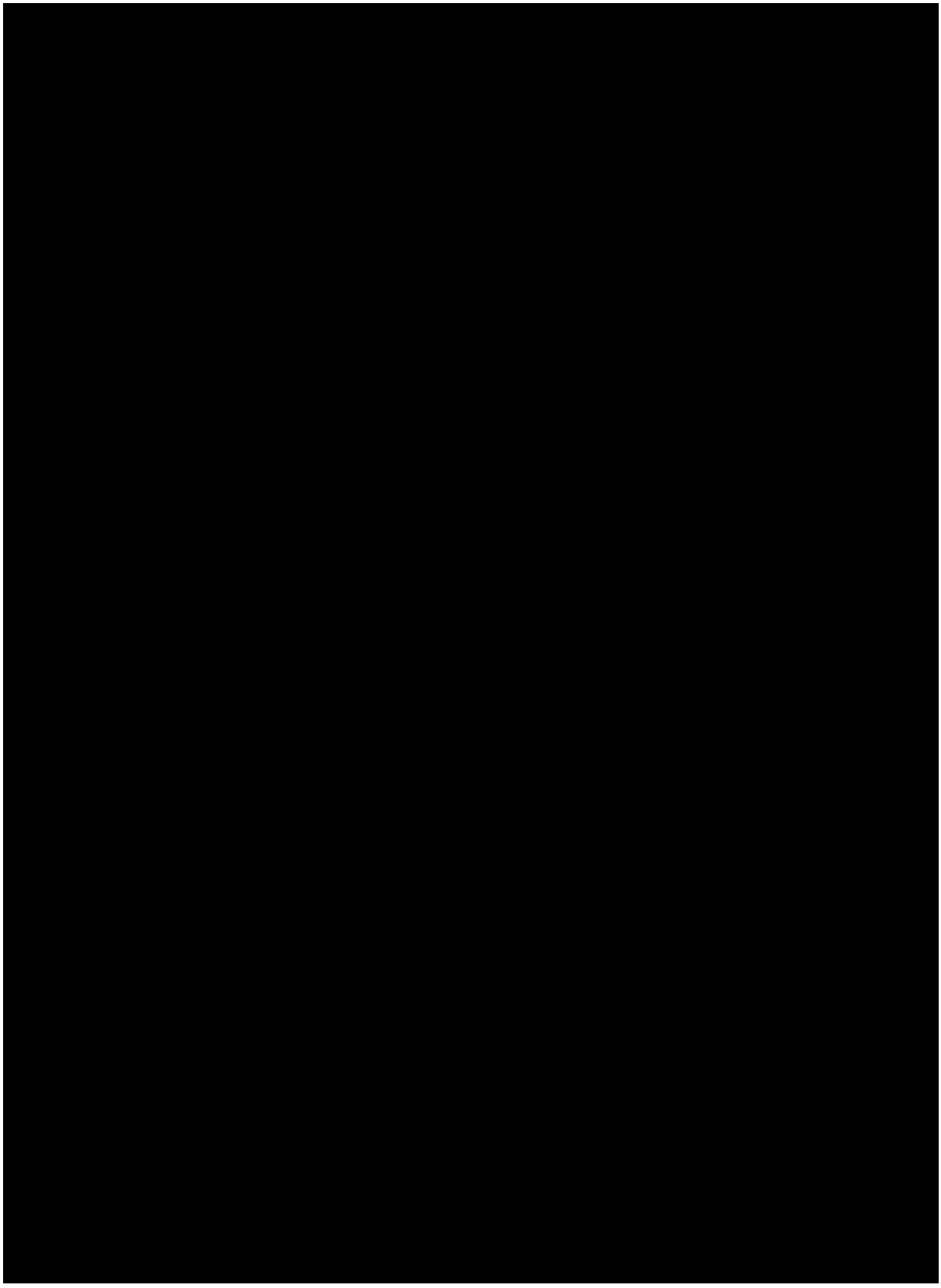

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Figure 3-7: Family Housing Communities, PHNC Study Area

1. Areas with Significant Natural Resource Value

Pearl Harbor

Pearl Harbor estuary and PHEC are located on the south-central portion of O'ahu (Figure 3-5). In 1903, the U.S. government completed limited dredging of the channel into Pearl Harbor; however, large craft, including battleships, were still unable navigate the sharp turns. In 1908, U.S. Congress passed an act to authorize $400,000 for dredging a deep channel at the harbor, and for the establishment and general development of the Navy Yard Pearl Harbor. The Navy dredged the PHEC in 1910. This channel allowed deeper draft, ocean-going vessels into the harbor, and, incidentally, increased the potential for introduced exotic marine species from hull fouling and ballast water.

Following the completion of PHEC in 1911, which allowed large craft to enter the harbor, many habitats of the harbor were drastically altered. The U.S. government contracted for the development of docks and operational facilities on the shorelines at Southeast Loch and Ford Island. The newly dredged lochs could accommodate larger ships. Dredged material was used to fill-in fishponds. In addition, urbanization of the East Loch occurred with the development of Pearl City. Hawaiian Electric Company (HECO) Waiau Power Station began discharging heated effluent into the East Loch. Discharge of sewage, runoff from sugarcane cultivation, and heavy metal pollutants from Shipyard activities increased significantly in the early part of the 20th century.

In the early 20th century, mangrove colonization along the shoreline of Pearl Harbor began and continues today. Beginning in the mid-century, increased sedimentation occurred in the harbor as a result of mechanized sugarcane cultivation and other land modifications. This created deltas at the stream mouths that provided an environment where mangrove was able to take hold and encourage more sediment deposition, leading to further encroachment by mangroves. Today, this cycle is evident at streams such as Hālawa, 'Aiea, Kalauao, Waimalu, Waikele, and Waiawa.

Prior to World War II, massive land clearing and dredging activities at Pearl Harbor created a need for disposal areas. Wetlands provided convenient areas to dispose of the debris and dredged material. Extensive filling occurred at Makalapa Crater, Pearl City Peninsula, and Waipi'o Peninsula during this period. Figure 3-8 shows the historic coastline (1928), modern coastline, and extant and buried fishponds.

During the mid-20th century, numerous industrial and residential treated and untreated sewage discharges into Pearl Harbor were commonplace including uncontrolled runoff from sugarcane plantations and mill waste. Non-point source discharge from upland urban development, storm water discharges, and Shipyard activities contributed to further decline of the water quality in Pearl Harbor. During this time, coliform bacterial counts at stream mouths in the East Loch and near oyster beds in West Loch ranged from hundreds of thousands to billions of bacteria per milliliter of water. Possibly due to such a ready, albeit polluted, supply of particulate food, the oyster population soared, reaching an estimated 36 million oysters in West Loch in the 1960s. During this same time, the number of introduced marine species increased substantially.

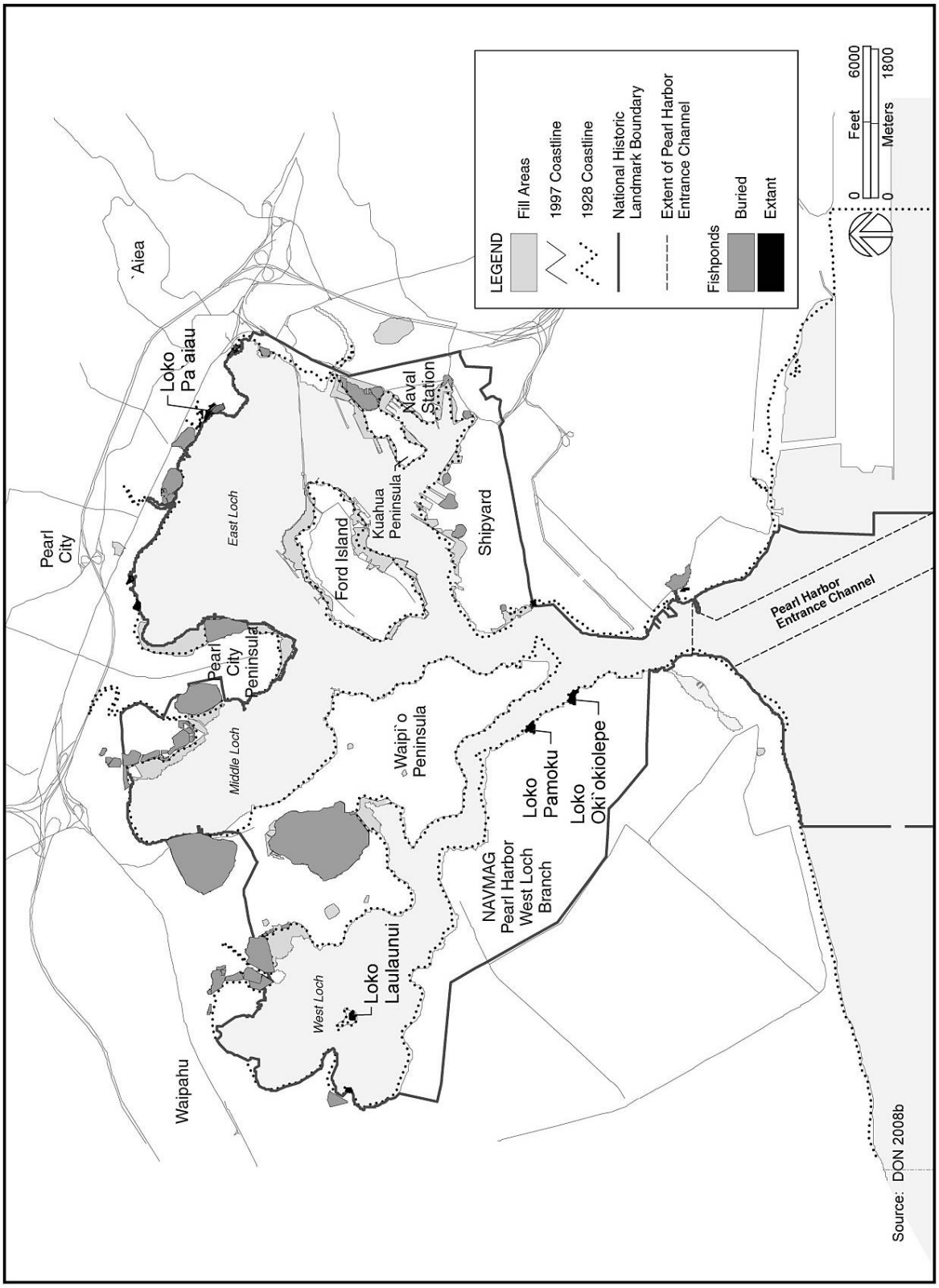


Figure 3-8: Historic Shoreline and Fishponds of Pearl Harbor

Between 1940 and 1972, Pearl Harbor ship traffic and Shipyard activities were at their peak and the environmental quality of the harbor was at its lowest point. Alteration of the shoreline and nearshore environment continued during this time with only four fishponds remaining (Figure 3-8). In 1972, an estimated 34 million oyster within Pearl Harbor died from parasitic fungus; algal blooms, with resulting fish mortalities, red tide caused by *Cochlodinium cateenatum* occurred; and large numbers of invertebrates died in Middle Loch, in the vicinity of the then-active Pearl City Sewage Treatment Plant. The invertebrate mortality may have been the result of the release of an unidentified substance that temporarily reduced the level of dissolved oxygen. During this time, the Navy completed major surveys of Pearl Harbor water quality, sediment pollution load, and biological communities, and HECO completed studies of its thermal outfall in East Loch. These surveys found diverse biological communities despite the degraded conditions and the mass mortalities.

Makalapa Crater

Makalapa Crater (Photo 3-2) is located on the eastern edge of PHNC (Figure 3-5). The Bernice P. Bishop and Queen Emma Estates originally owned the Makalapa Crater tract. The steep crater walls and marshy lowlands within the crater restricted early use of the Makalapa Crater. Prior to use by the Navy, the area was rural and sugarcane cultivation may have occurred on a portion of it. In 1930, a pond was present in the crater which may have been used for sugarcane irrigation. During the 1930s, dredge spoil was disposed of in the former pond area and crater floor. Condemnation proceedings for the Navy acquisition of the property began in 1939. The Navy used the land acquired at Makalapa Crater for housing as well as a high-level administration area at its northern rim. The Navy commissioned the administration area on 15 July 1942. It became the headquarters for COMPACFLT (DON 2008b).

Photo 3-2: aerial view of Makalapa crater

During World War II, following the Pearl Harbor attack, the Navy disposed of materials from the cleanup operations and damaged equipment, such as metal scrap, engine parts, empty ammunition casings, airplane parts, and ship parts, in the interior of Makalapa Crater. In the 1950s and 1960s, the crater floor was used for disposal of general Navy waste from base dumpsters and other nearby activities. From 1972 through 1976, part of the crater floor was filled with clean fill (NAVFAC PAC 2002a). Currently, the developed portions of Makalapa Crater are used for administrative purposes and family housing and the undeveloped portions are heavily vegetated.

Pearl City Peninsula

Photo 3-3: aerial view of Pearl City Peninsula

Pearl City Peninsula (Photo 3-3) is located on the north end of Pearl Harbor and separates Middle Loch from East Loch (Figure 3-5). Prior to alteration by human activities, much of Pearl City Peninsula was a deltaic marsh associated with the Waiawa Stream. Pearl City Peninsula is part of the Mānana ahupua'a, a traditional Hawaiian subdivision of land which generally describes a pie-shaped piece of land extending from the top of a local mountain, in this case the Ko'olau summit, to the shore. Ancestral Hawaiian people modified the Pearl City Peninsula for fish cultivation. The area was cultivated for production of taro through the late 1800s and had numerous fishponds (loko), some rice fields, pasture land at the tip, and oyster beds off shore in the 19th century (DON 2008b).

In the 1880s and 1890s there were two clusters of residential lots on Pearl City Peninsula which were part of the Pearl City suburb that continued until the beginning of World War II. One group of lots was located mauka of the O'ahu Railway and Land (OR&L) rail line (at the northern portion of the peninsula) and the other in the southern half of the peninsula which was served by a spur of the main OR&L line (present location of Lehua Avenue). Several families lived at Pearl City. Some wealthy families purchased more than one waterfront lot and constructed large estates. These estates served as vacation and weekend homes or as retirement homes. Other Pearl City residents built rental units on their lots and supplemented their rental income by doing yard work or other jobs for the wealthy landowners. Some families grew taro, rice and other crops in the wetland area between the rail line and the subdivided lots. Only two pre-World War II houses remain on the peninsula and now are part of the Navy's Pearl City Peninsula Housing Community (DON 2008b).

Pan American Airways (Pan Am) had regular airline passenger service between Manila and San Francisco, via Pearl City Peninsula, beginning in October 1936 and ending at the beginning of World War II. Pan Am had facilities on the west side of the peninsula in the area now known as the "Pan Am" Housing Area (now part of the Pearl City Peninsula Housing Community) (DON 2008b). Prior to World War II, landowners filled fishponds within the Pearl City Peninsula for residential development. After 1930, Loko Welokā, on the east side of the peninsula, and Loko Pā'au'au, on the west side (north of the historic Pan Am housing area), had been filled (DON 2008b).

The Navy used Pearl City Peninsula for warehousing and fuel storage during World War II. Civilian property owners unofficially turned over their property to the Navy within a few days after the attack on Pearl Harbor (7 December 1941) which coincided with the U.S. entering World War II. A declaration of taking (Civil No. 505, Federal District Court) under the First War Powers Act, which allowed the Navy to acquire the properties on the south and west shorelines of the peninsula, was finalized on 21 March 1944. The Navy acquired the entire peninsula below the railroad tracks after World War II (DON 2008b).

The Navy constructed Pearl City Fuel Annex and the Victor Docks in the late 1940s. During this time the Navy altered the shape of the peninsula by filling the southern and western shorelines with dredged materials. The Navy constructed warehousing facilities on the southern portion of the peninsula at that time. In the 1940s, 1950s, and 1960s, the Navy constructed housing units and recreational facilities on the peninsula. The Pearl City Peninsula landfill and sewage

treatment plant began operations in 1965. In the mid 1990s, 164 housing units were constructed (NAVFAC PAC 2003b).

Red Hill Storage Area

The Red Hill Storage Area (Photo 3-4) is located east of Āliamanu Crater and Moanalua Freeway (Figure 3-5). The Navy began construction of the Red Hill Fuel Storage facility in 1938. It was completed in 1942. The facility contains 20 large (100 ft [31 m] diameter by 250 ft [76 m] tall) underground storage tanks (USTs), each with a capacity of 12.6 million gallons (47.7 million liters). These tanks have been used chiefly to store Navy special fuel oil, diesel fuel, jet fuel, aviation gas, and motor gasoline. Navy contractors built a system of tunnels with access portals known as "adits" concurrently with the USTs to connect the tanks to each other and to associated Navy facilities. The Navy constructed a water plant in Adit 3 in 1942 including a production well and chlorinator station. Associated with the water plant are a diesel engine building, added outside of the tunnel in 1966, and a turbine generating unit, added outside of the plant in 1977 (NAVFAC HI undated).

Photo 3-4: aerial view of Red Hill Storage Area

Photo 3-5: aerial view of Waiawa Watershed

Waiawa Watershed

The Waiawa Watershed (Photo 3-5) serves as CNRH's primary water source and is located north of the Pearl City Industrial Park (Figure 3-5). The Navy acquired Waiawa Watershed on 13 August 1945 as part of Civil No. 533. Contractors completed the construction of the Waiawa Pump Station in 1951. The Navy has used the potable water at this site for its major source of the drinking water since that time. The remainder of the area is undeveloped (NAVFAC HI undated).

NAVMAG PH West Loch Branch/Waipi'o Peninsula

NAVMAG PH West Loch Branch (including Waipi'o Peninsula) (Photo 3-6) is located on the west side of Pearl Harbor (Figure 3-5). Prior to military use, the land was undeveloped with kiawe trees and a few fishponds along the harbor channel and a salt works located at Iroquois Point lagoon. The 'Ewa Plantation Company cultivated sugarcane on much of Waipi'o Peninsula and the West Loch area during the 20th century. Beginning in 1929, they began leasing land within what is now NAVMAG PH West Loch Branch's ESQD arc, prior to the Navy acquiring the

Photo 3-6: aerial view of NAVMAG PH West Loch Branch

land. The Navy continued to lease land within the West Loch area and Waipi'o Peninsula to the 'Ewa Plantation Company until 1970 when the company was sold to O'ahu Sugar Company. O'ahu Sugar Company continued to lease land from the Navy until 1995.

In 1922, the U.S. Army established Fort Weaver military reservation on the water's edge in what became the Iroquois Point housing area, south of the naval magazine branch. By 1924, the Army had built two 16- in (40.6-cm) guns (Battery Williston), two large concrete emplacements, several service magazines, and a narrow-gauge railroad along with the guns and magazines. Between 1929 and 1931, the Navy acquired 213 ac (86.2 ha) at West Loch for a receiving depot, ordnance handling, and storage. In 1930, the Navy moved Naval Ammunition Depot from Kūāhua Island (now Kūāhua Peninsula) to West Loch. The West Loch depot included Marine Corps Officer's quarters and enlisted barracks as well as the initial Whiskey Wharf waterfront buildings. In 1931, the Navy awarded a contract for construction of 135 buildings, 13 mi (20.9 km) of railroads, 15 mi (24 km) of paved roads, and ancillary utilities. In 1939, the Navy acquired an additional 358 ac (144.9 ha), enlarging the depot to 537 ac (217.3 ha). During World War II, the Navy established a staging area for the war effort in the Pacific –the Advance Base Reshipment Depot – at West Loch.

The Navy acquired approximately 3,879 ac (1,569.8 ha) of land in West Loch from Campbell Estate through the post-World War II West Loch Perimeter Acquisition Project. An additional 160 ac (64.7 ha) within the ESQD were acquired by the Navy in a land exchange with the Hawai'i Meat Company in 1964. The remaining property was acquired from Campbell Estate in 1980. The land at Waipi'o Peninsula was acquired through condemnation or civil proceedings between 1909 and 1948.

2. Abbreviated History of Highly Developed and Industrial Areas

The following paragraphs provide an abbreviated history for the 14 highly developed and industrial areas within PHNC that have limited natural resource value.

Beckoning Point

Beckoning Point is located on the east side of the Waipi'o Peninsula, immediately adjacent to Middle Loch (Figure 3-6). During the early part of the 20th century, O'ahu Sugar Company cultivated sugarcane on much of Waipi'o Peninsula where Beckoning Point is located. The Navy acquired Beckoning Point from the Estate of John 'I'i in 1944. Construction of facilities at Beckoning Point began in 1942. The Navy demolished some of the buildings prior to 1996 and others in 1999 (NAVFAC PAC 2004a). The Navy had two new buildings, a sand blasting shop, and a paint shop constructed at the site in 1996. The major tenant at Beckoning Point is the Navy's magnetic silencing facility or "degaussing facility."

Bishop Point

Bishop Point is located on the west side of Hickam Air Force Base and immediately adjacent to the east side of the PHEC (Figure 3-6). Early use of Bishop Point involved activities for the defense of Pearl Harbor. Specifically, the Navy utilized Building 54 as a cable lay-down facility for anti-submarine cables. During World War II, the area housed Shore Intermediate Maintenance Activities (SIMA); this use continued through the 1970s. The function of SIMA was to provide intermediate repairs to ships that were less extensive than those performed in the Shipyard (i.e., pump repairs, steam equipment repairs, air compressor repairs). Navy personnel would bring the equipment off the ships and perform repairs on site. In addition to performing

repairs, SIMA was also responsible for training personnel in conducting this type of repair. SIMA later became part of the Intermediate Maintenance Facility (IMF), which later merged with the Shipyard activity. Since the 1970s, the principle use of the area has been for scuba diver training and underwater salvage operations (NAVFAC PAC 20001b).

Federal Fire Department

The FFD is located south of Makalapa Crater on a corner location fronting Kamehameha Highway (Figure 3-6). The building currently used by the FFD was originally built in 1986 and was used as a Chief Petty Officer's Club. Later, it became the Personnel Support Detachment office. Recently, it was made into the headquarters for the FFD on O'ahu.

Ford Island

Ford Island is located in the center of Pearl Harbor, south of Pearl City Peninsula, east of Waipi'o Peninsula, and north of the Shipyard (Figure 3-6). Due to Ford Island's limited freshwater, there was probably little pre-contact habitation, except short-term occupation for fishing, gathering pili grass, and possible seasonal cultivation of dryland crops. In the 19th century, fishermen and melon growers were living on Ford Island. Various types of livestock, including sheep, goats, hogs, and rabbits were also raised on the island for provisioning visiting ships (DON 2008b).

An artesian well was drilled on the island in 1889 to make large-scale cultivation of sugarcane possible. By this time, the John 'I'i Estate owned the island and had a vacation house on the island. At some date the 'I'i Estate leased much of the acreage on Ford Island to the O'ahu Sugar Company. By 1914, plantation buildings were located on the west side of the island near the well and irrigation ditches and a reservoir were located near the northeastern tip of the island. Transportation of the sugarcane from the island was by cable ferry from a landing at the southwest corner of the island to Waipi'o Peninsula where a plantation railroad line ended (DON 2008b).

Initial development of military facilities at Ford Island occurred between 1912 and 1919. This included the establishment of Naval Air Station (NAS) Ford Island and Army Air Station Luke Field at Ford Island in 1917. Hangar and support facilities associated with Luke Field Army Air Station were located on the southwestern side of the island. During this time frame, the Navy was responsible for personnel and equipment transport via seaplanes. The area between the Army and Navy Air Stations was a joint use, unpaved runway. During the 1930s, filling of areas along the eastern and northern shores, from the dredging of the harbor channel area, increased the size of Ford Island by 116 ac (47 ha) or 20 percent (NAVFAC PAC 2000a).

Prior to and during World War II, Ford Island provided moorage and support to most of COMPACFLT and also was the home of NAS Ford Island. Prior to U.S. participation in World War II, Ford Island was the location of "battleship row," where the Navy docked many ships that were damaged during the 7 December 1941 Japanese attack. Naval Station obtained ownership of Ford Island when the NAS was disestablished in 1962. Naval Station controls the waters of Pearl Harbor and land adjacent to Pearl Harbor including Ford Island (DON 2008b).

Fort Kamehameha Wastewater Treatment Plant

Fort Kamehameha WWTP is located on the west side of Hickam Air Force Base and on the east side of PHEC (Figure 3-6). Historically, Loko Ke'oki, Loko Waiaho, and Loko Lelepaua were

located southeast of and within 0.4 to 1.2 mi (0.5 to 2.0 km) of the WWTP. Native Hawaiians constructed these fishponds prior to European contact in 1778; however, the exact dates of construction for these ponds are not known. These ponds were systematically filled between 1870 and the early 1900s and probably no longer existed by 1919. Around 1900, the Honolulu Plantation Company expanded sugarcane production into the Fort Kamehameha area. In 1906, Watertown, a housing camp for dredge and dock workers employed at PHNC, was constructed north of Fort Kamehameha. The U.S. military acquired Fort Kamehameha in 1907. Dredge spoils from Pearl Harbor were placed in the adjacent wetlands beginning in 1908. Between 1913 and 1915, the military completed housing, gun batteries, and a connecting railway system in the area southeast of the WWTP. By 1935, sugarcane production ceased in the area and Watertown was demolished in order to make room for the expansion of the John Rogers Airport (now Honolulu International Airport). The Navy constructed the WWTP in 1970 (NAVFAC PAC 2001a).

Moanalua Shopping Center/Navy Exchange/Commissary

MSC/NEX/Commissary is located northwest of the Navy Marine Golf Course and south of Radford Drive (Figure 3-6). In the early part of the 20th century this area was in sugarcane cultivation, which may have continued to the 1940s. By 1953, the Navy had developed this area with roadways and structures. The Navy had constructed portions of the MSC by 1959 and it was expanded by 1983 (NAVFAC PAC 2004b). The shopping center was demolished in 2005 and rebuilt in 2006. The NEX and Commissary were opened at their present location in October 2003. Prior to the construction of these facilities, the land areas was used by the Navy for commercial purposes.

Naval Sea Inactive Ships On-Site Maintenance Office

NISMO is located on the northeast side of the Waipi'o Peninsula, east of the Ted Makalena Golf Course (Figure 3-6). The O'ahu Sugar Company utilized land on Waipi'o Peninsula for sugarcane production from the early 1900s through 1995 (NAVFAC PAC 2002b). The Navy established NISMO on the peninsula in 1946 for the maintenance of inactive service craft and dry docks. In December 1954, the Navy created the U.S. Naval Inactive Service Craft Facility (INACTSERVCRAF) under the Commandant, 14th Naval District. The Chief of Naval Material acquired command of INACTSERCRAF in 1969 from the Chief of Naval Operations. In that year, the Navy expanded the mission to include naval ships as well as service craft, and changed the facility name to Inactive Ship Facility (INACTSHIPFAC). In 1975, the Navy disestablished INACTSHIPFAC PH and reassigned it to INACTSERVCRAF, Bremerton, Washington. In October 1982, the Navy converted the facility to government-owned/contractor-operated activity, and changed the name of the facility to Naval Sea Systems Command Detachment (NAVSEADET) Naval Inactive Ship Maintenance Facility (NISMF) Pearl Harbor. In 2001, the Navy changed the facility name to NISMO (NAVFAC PAC 2002b).

Naval Station

The Naval Station is located immediately adjacent to the East Loch of Pearl Harbor and west of Kamehameha Highway (Figure 3-6). The Naval Station began in 1912 as the receiving ship at Hospital Point (in the Shipyard). In 1937, the Navy transferred the Naval Station to a small barge near the SUBASE where it remained until 1940. At this time, the Navy renamed the Naval Station to "Receiving Station" and relocated it to Building B150, its present headquarters. In 1955, the Navy established the Naval Station Pearl Harbor in place of the Receiving Station. Naval Station provided support to the operating forces of the Navy, dependent activities, and

other commands as assigned (NAVFAC PAC 2003a). On October 1, 2010, the Pearl Harbor Naval Base and Hickam AFB were formally combined into the JBPHH (DON 2011b).

Prior to construction of the SUBASE, individuals described the Quarry Point area as a "wasteland" and "a swamp covered with cactus." The Navy cleared the area for building sites; the first submarines to operate in the area arrived in 1916 and were berthed at Magazine Island. Officially commissioned in 1920, the Navy built the first permanent building at the SUBASE in 1923. In 1924, construction commenced on Sierra Piers 6 through 9. The Navy constructed the whole area at the east end of Quarry Loch over a former Hawaiian fishpond (Loko Wailolowai) to provide additional land for the SUBASE. By 1925, the Navy constructed about 25 permanent buildings there. The expansion of SUBASE Pearl Harbor reached its peak in 1944, when there were 6,633 personnel serving the base. Magazine Island was connected to the mainland with dredged spoils during World War II (NAVFAC PAC 2003a).

Kūāhua Island, the site of the initial Naval Ammunition Depot (NAD) at Pearl Harbor, was included in the Navy's initial land acquisition in 1902. Prior to its development by the Navy, the area consisted of the island, wetlands, kiawe trees, and coral roads. By the end of the 1912, construction of the NAD was in progress. Kūāhua Island became Kūāhua Peninsula during World War II when the Navy filled a fishpond and altered the original island shoreline by cutting, filling, and construction of wharves. In January 1946, the Navy commissioned the Naval Supply Center Pearl Harbor at Kūāhua Peninsula. It was renamed FISC in March 1993 (NAVFAC PAC 2003a).

Navy-Marine Golf Course

The Navy-Marine Golf Course is located northeast of Nimitz Highway and is bound on the north by Moanalua Terrace Housing Community, on the east by Catlin Park Housing Community, and the west by MSC/NEX/Commissary (Figure 3-6). The land area in and around the Navy-Marine Golf Course was used for sugarcane production in the early part of the 20th century; these activities continued to the early 1940s (U.S. Department of the Army 1909-1913, 1943). By 1953, a single roadway and structure were located on the site, which was part of the Naval Reservation (U.S. Geological Survey [USGS] 1953). By 1959, the Navy-Marine golf course was present (USGS 1959) and the Navy has maintained the area as a golf course since then.

Ohana Nui

Ohana Nui is located south of Nimitz Highway and north of Hickam Air Force Base housing (Figure 3-6). Sugarcane cultivation occurred in the Ohana Nui area in the early part of the 20th century. The Navy developed the area during World War II for civilian housing and recreation purposes. After World War II, the Navy constructed athletic fields and allowed tenants to construct several churches and schools in the area.

Public Works Center Compound

The Public Works Center Compound is located south of Salt Lake Boulevard, northwest of the Moanalua Terrace Housing Community, and north of the MSC/NEX/Commissary (Figure 3-6). Sugarcane cultivation occurred in the area around the Public Works Center Compound in the early part of the 20th century. The Navy constructed the Public Works Center Compound in 1946. It has been in continuous use by the Navy since that time for workshops, warehousing, and administrative purposes. The Navy established the Public Works Center as independent command in 1954. From approximately 1960 to 1977, Public Works Center underwent several

consolidations during which it extended its geographic responsibility from PHNC to most of the O'ahu-based Navy Commands (NAVFAC PAC 2002d). Today, the entity formerly known as the Public Works Center is now part NAVFAC HI.

Richardson Recreation Center

Richardson Recreation Center is located west of Kamehameha Highway, south of McGrew Point Housing Community, north of the Naval Station, and east the Southeast Loch of Pearl Harbor (Figure 3-6). The Navy constructed many of the recreational facilities at the Richardson Recreation Area, which includes 'Aiea Landing, in 1943. The abandoned 'Aiea water pumping plant, the former fire fighting training area, demolished maintenance shops, and the former ferry terminal building, and former warehouses were located in the area in 1952. However, by 1968, the Navy had demolished the warehouses and constructed a parking area in the vicinity of what is now the U.S. Ship (USS) Arizona Visitors Center. Marina facilities and docks were located in the Richardson Recreation Area from at least 1952 through 1997. The USS Arizona Visitors Center and the USS Bowfin Submarine Museum and park were constructed in the 1980s (NAVFAC PAC 2002e).

Salt Lake Storage Area

The Salt Lake Storage Area is located north of Nimitz Highway, south and west of the Doris Miller Park Housing Community, and southeast of Catlin Park Housing Community (Figure 3-6). The Salt Lake Storage Area consists of five warehouses that were constructed in 1943 as part of a much larger Navy warehousing area known as the Advance Base Construction Depot. Of the extant structures, Warehouse 4 was initially used as a coffee roasting plant, Warehouse 8 was used for military warehousing, and Warehouses 12, 16, and 101 were originally used for military storage. The Salt Lake Storage Area is now used by FCMC in support of Navy family housing.

Shipyard

The Shipyard is located south of the Southeast Loch of Pearl Harbor, west of the PHEC, and north of Hickam Air Force Base (Figure 3-6). The Shipyard was part of the original Navy base land acquisition with construction commencing in 1908 and continuing on as the U.S. Congress allocated more funding for the Naval Station during the first half of the 20th century. The U.S. government appropriated money for construction of a high-powered radio station, formerly situated in the Hospital Point Housing Community, in 1914; the Navy activated the station in 1916. The Naval Hospital Reservation was under construction at the same time in the same area as the radio station. In July 1917, the hospital received its first patient. Some of the facilities related to the hospital and radio station development still exist; however, the Navy removed the main facilities for these functions (NAVFAC PAC 2003d).

Hydrostatic forces initially destroyed Dry Dock No. 1 in 1913 while it was under construction; construction crews finally completed it in 1919. Buildings 1 (administrative building), 2 (demolished pipe and plumbing shop), 4 (ship fitters and boiler shop), 5 (forge and propeller shop), 6 (foundry), 7 (woodworking shop), 8 (former power plant), 12 (boat shop), 14 (pattern shop), S17 (dry dock pump well), 66 (warehouse), and 72 (sheet metal shop) were all constructed in the Shipyard prior to 1925. In addition, the Navy built several residential quarters during this period (NAVFAC PAC 2003d).

In 1913, construction began on the first Marine Barracks building (Building 221) and officers' quarters. Central Avenue, South Avenue, the street along the officer's quarters, and former Hālawa Street (no longer exists) bounded the area set aside for the Marines. During the 1920s and 1930s, the Navy constructed several buildings in this area. During this time, the Navy's ships transitioned from coal-burning steam plants to oil-burning steam plants and the Navy constructed the Lower Tank Farm in this area adjacent to the former coaling station (NAVFAC PAC 2003d).

The Navy made major additions to the Shipyard in the 1930s, which included the expansion and construction of existing repair basins, residential development at Hospital Point (after the demolition of the radio station), and an extension to the power plant. After the outbreak of war in Europe in 1939, extensive construction began at PHNC, including the addition of two new dry docks adjacent to the existing dry dock. Numerous buildings, many temporary in nature, were built during this time. New facilities constructed included dry docks, berths, building annexes, barracks, and temporary housing. Due to its strategic location in the Pacific, PHNC was one of the most extensive, if not most extensive, defensive installations in the world by the end of World War II (NAVFAC PAC 2003d).

After World War II, due to the emergence of the Cold War and the growing debate over nuclear versus conventional warfare, little additional construction took place at the Shipyard. The primary construction activity since that time has been building upgrades, particularly to support nuclear-powered ships (NAVFAC PAC 2003d).

3. Abbreviated History of Family Housing Communities

The following paragraphs provide an abbreviated history for the 19 Navy family housing communities within PHNC. Halsey Terrace, Hokulani, McGrew Point, Moanalua Terrace, and Radford Terrace housing communities that are now managed by FCMC.

Catlin Park Housing Community

The Catlin Park Housing Community is located north of Nimitz Highway, southeast of the Navy-Marine Golf Course, south of Halsey Terrace Housing Community, and west of the Salt Lake Storage Area (Figure 3-7). The Navy constructed Catlin Park Housing Community in two phases, in 1968 and 1973 on land previously used by the Navy for warehousing during World War II. Prior to development by the Navy, this land was used for sugarcane cultivation (NAVFAC PAC 2002c). All of the housing associated with this housing community was demolished in 2006-2007 and new FHU were recently constructed at the site.

Doris Miller Park Housing Community

The Doris Miller Park Housing Community is located north of Nimitz Highway and Salt Lake Storage Area, south of Halsey Terrace Housing Community, east of Radford Terrace Housing Community, and west of the Catlin Park Housing Community (Figure 3-7). The Navy constructed the Doris Miller Housing Community between 1990 and 1996 on land previously used by the Navy for warehousing during World War II. Prior to development by the Navy, this land was used for sugarcane cultivation (NAVFAC PAC 2006g, h).

Ford Island Housing Community

Figure 3-7 shows the locations of the Luke Field, Nob Hill, and Kamehameha housing areas of the Ford Island Housing Community. Section 3.1.1.5 presents a discussion of the land use at Ford Island. Constructed in 1922 in support of the Army Air Station Luke Field, the Luke Field housing area contains 20 historical FHU. Built between 1923 and 1936, the Nob Hill housing area is located on the southeast side of the island and contains 20 historic FHU. The Navy constructed the Kamehameha housing area in 2003 in the center of the island. It contains 140 FHU (NAVFAC PAC 2006g, h).

Halawa Housing Community

The Halawa Housing Community is located north of the H-1 Freeway (Figure 3-7). The 96 FHU of the Halawa Housing Community were constructed in 1973 (NAVFAC PAC 2006g, h). FCMC demolished the 96 FHU and replaced them with 80 FHU (NAVFAC PAC 2008a, personal communication).

Hale Alii Housing Community

The Hale Alii Housing Community is located within the Shipyard, south of the Southeast Loch of Pearl Harbor (Figure 3-7). The area that was to become Hale Alii was part of the original 1902 land acquisition at Pearl Harbor for the proposed naval installation. Prior to construction of housing, this land area may have been used for sugarcane cultivation. The 13 Craftsman style buildings (containing 14 FHU) at the Hale Alii Housing Community were built between 1914 and 1916 by the Navy in support of the Navy Yard (now known as the Shipyard). Hale Alii was designed as a residential oasis for high-ranking officers stationed at PHNC, and was within easy reach of the administrative and shop facilities at the Navy Yard (DON 2008b).

Hale Moku Housing Community

The Hale Moku Housing Community is located just north of the Nimitz Gate entry to PHNC (Figure 3-7). The Navy originally constructed Hale Moku Housing Community in 1941 with 556 FHU (on land previously used for sugarcane cultivation and a railroad (U.S. Department of the Army 1909-1913, 1943). Rebuilt in 2000-2001, the housing community is comprised of 318 FHU.

Halsey Terrace Housing Community

The Halsey Terrace Housing Community is located south of Salt Lake Boulevard, west of Radford Terrace Housing Community, and north of Doris Miller Park Housing Community (Figure 3-7). The Navy originally constructed Halsey Terrace Housing Community in 1960. It contained 504 FHU (Directorate of Oahu Consolidated Family Housing [DOCFH] 1990). The area may have been used for sugarcane cultivation prior to development. The housing community was demolished and 477 new FHU were constructed there in recent years.

Hokulani Housing Community

The Hokulani Housing Community is located just north of the Nimitz Gate entry to PHNC (Figure 3-7). The Navy originally constructed the Hokulani Housing Community in 1970. It contained 190 FHU (DOCFH 1990). Prior to development the areas was used for sugarcane cultivation

and a railway (U.S. Department of the Army 1909-1913, 1943). The housing community was demolished and 477 new FHU were constructed in recent years.

Hospital Point Housing Community

The Hospital Point Housing Community is located on the west side of the Shipyard, immediately adjacent to the east side of the PHEC (Figure 3-7). It was part of the original 1902 land acquisition at PHNC for the proposed naval installation. Built between 1915 and 1929, the housing at Hospital Point consists of 19 historic FHU including single-family, duplexes, and one triplex building. The housing was built in support of a radio station and Navy hospital formerly located in this area (DON 2008b). Prior to development this area may have been used for sugarcane cultivation (U.S. Department of the Army 1909-1913, 1943).

Little Makalapa Housing Community

The Little Makalapa Housing Community is located south of Makalapa Crater, east of Kamehameha Highway, and north of the FFD (Figure 3-7). The Navy constructed a total of 30 FHU at Little Makalapa in 1941 to house civilian Navy personnel. The Little Makalapa Housing Community has been in continuous use as housing since that time. The Navy repurposed some of the buildings from the housing community and demolished the remainder (NAVFAC PAC 2006h).

Makalapa Housing Community

The Makalapa Housing Community is located within Makalapa Crater (Figure 3-7). Section 3.1.1.5 presents a discussion of the historic land use of Makalapa Crater. Constructed in 1941 to house Navy personnel, the Makalapa Housing Community has been in continuous use as housing since that time.

Maloelap Housing Community

The Maloelap Housing Community is located north and west of Moanalua Terrace Housing Community and south of Salt Lake Boulevard (Figure 3-7). The Navy constructed 13 of the FHU at the Maloelap Housing Community in 1947. The Navy completed a second phase of construction in 1973 adding 10 more FHU (NAVFAC PAC 2006h). Prior to use as a housing community, this area was used for sugarcane cultivation (U.S. Department of the Army 1909-1913, 1943). All but one of the FHU of this housing community were demolished in 2006-2007 and new FHU have been constructed at the site.

Manana Housing Community

The Manana Housing Community is located at the end of Acacia Road, northwest of the Pearl City Post Office (Figure 3-7). The Navy constructed the Manana Housing Community in 1959 on previously undeveloped land (NAVFAC PAC 2006g, h). Additional FHU owned by the Marine Corps are located immediately west. All but two FHU in this housing community were demolished in 2006-2007. No new construction is planned.

Marine Barracks Housing Community

The Marine Barracks Housing Community is located within the Shipyard (Figure 3-7). The Marine Barracks Housing Community consists of three single-family homes (3 FHU) built in

1913, one duplex building (2 FHU) built in 1914, and six FHU constructed between 1955 and 1965. Prior to use as a housing community, the area was used for sugarcane cultivation (U.S. Department of the Army 1909-1913, 1943).

McGrew Point Housing Community

The McGrew Point Housing Community is located north of Richardson Recreation Center, on the northeast side of the East Loch of Pearl Harbor (Figure 3-7). The McGrew Point Housing Community originally consisted of 140 FHU constructed in 1960 on land previously used by the Navy. This housing community underwent phased demolition and 144 FHU were completed at McGrew Point in 2008.

Moanalua Terrace Housing Community

The Moanalua Housing Community is located south of Salt Lake Boulevard, south of the Public Works Center Compound, north of the Navy-Marine Golf Course, and west of the Maloelap Housing Community (Figure 3-7). The Moanalua Housing Community originally consisted of 752 FHU constructed in 1953 on land previously used for sugarcane cultivation (U.S. Department of the Army 1909-1913, 1943). The Navy demolished the original structures and replaced them with new FHU in the late 1990s.

Pearl City Peninsula Housing Community

The Pearl City Peninsula Housing Community is located within the Pearl City Peninsula on the northern end of Pearl Harbor (Figure 3-7). Section 3.1.1.5 presents a summary of the historic land use of Pearl City Peninsula. Two historic single family homes within the Pan Am housing area were constructed prior to 1941. In addition, the Navy relocated three additional historic single family homes to the Pan Am housing area after World War II. An additional 74 FHU were constructed in 1954, 437 FHU in 1965, and 56 FHU in 1970 (DOCFH 1990). The Navy demolished and replaced the FHU outside of the Pan Am housing with 630 FHU in 2002 (NAVFAC PAC 2006 g, h).

Radford Terrace Housing Community

The Radford Terrace Housing Community is located west of Pu'uloa Road, north of Nimitz Highway, South of Salt Lake Boulevard, and east of Halsey Terrace Housing Community (Figure 3-7). The Radford Terrace Housing Community was originally constructed in 1954 on land previously used for sugarcane cultivation (Department of the Army 1909-1913, 1943). The housing community was completely demolished and rebuilt in recent years and currently contain 402 FHU (NAVFAC PAC 2008a, personal communication).

Red Hill Housing Community

The Red Hill Housing Community is located south of the Moanalua Freeway and adjacent to the Army's Aliamanu housing community (Figure 3-7). The Red Hill Housing Community is associated with the construction of the Red Hill underground fuel facilities (Section 3.1.1.5). The housing was built as part of the construction camp that supported the massive undertaking. Six houses were built in 1941 for civilian supervisors and two barracks structures (later four duplex units) were built in 1944 (DON 2008b). All ten of the FHU at Red Hill were demolished and no new FHU are planned.

4. Cultural Resources

Previous cultural resource studies have identified historic properties at PHNC, including Native Hawaiian sites, ranching and agricultural sites, and World War II era military sites. Cultural resources at PHNC are addressed in a separate document (ICRMP [DON 2008b]); however, a brief discussion of PHNC cultural resources and their relationship to natural resources management is presented here. The majority of PHNC has been designated a NHL (Figure 3-9) and is listed on the NRHP. Landmarks and historic sites within the PHNC INRMP study area include: (1) U.S. Naval Base, Pearl Harbor; (2) USS Arizona and Memorial; (3) USS Utah; (4) USS Bowfin; (5) Nimitz Headquarters, Commander in Chief Pacific Fleet (Building 250); and (6) Loko 'Oki'okiolepe.

Photo 3-7: Loko 'Oki'okiolepe, covered with mangrove

Buried and extant Hawaiian fishponds are important archaeological resources and an important land management element of the INRMP because they are wetlands and can provide important habitat to native species. These fishponds, or loko, include Loko 'Oki'okiolepe (Photo 3-7) which is listed on the NRHP, and 23 fishponds are listed on the State Inventory of Historic Places (SIHP). These fishponds are protected under the NHPA . Four of the fishponds are extant: (1) Loko Laulaunui (SIHP No. 50-80-13-00140); (2) Loko Pa'aiau (SIHP No. 50-80-09-00108); (3) Loko Pamoku (SIHP No. 50-80-13-00142); and (4) Loko 'Oki'okiolepe (SIHP No. 50-80-13-00143). The maintenance and preservation of the extant fishponds is mandated under Section 110 of the NHPA.

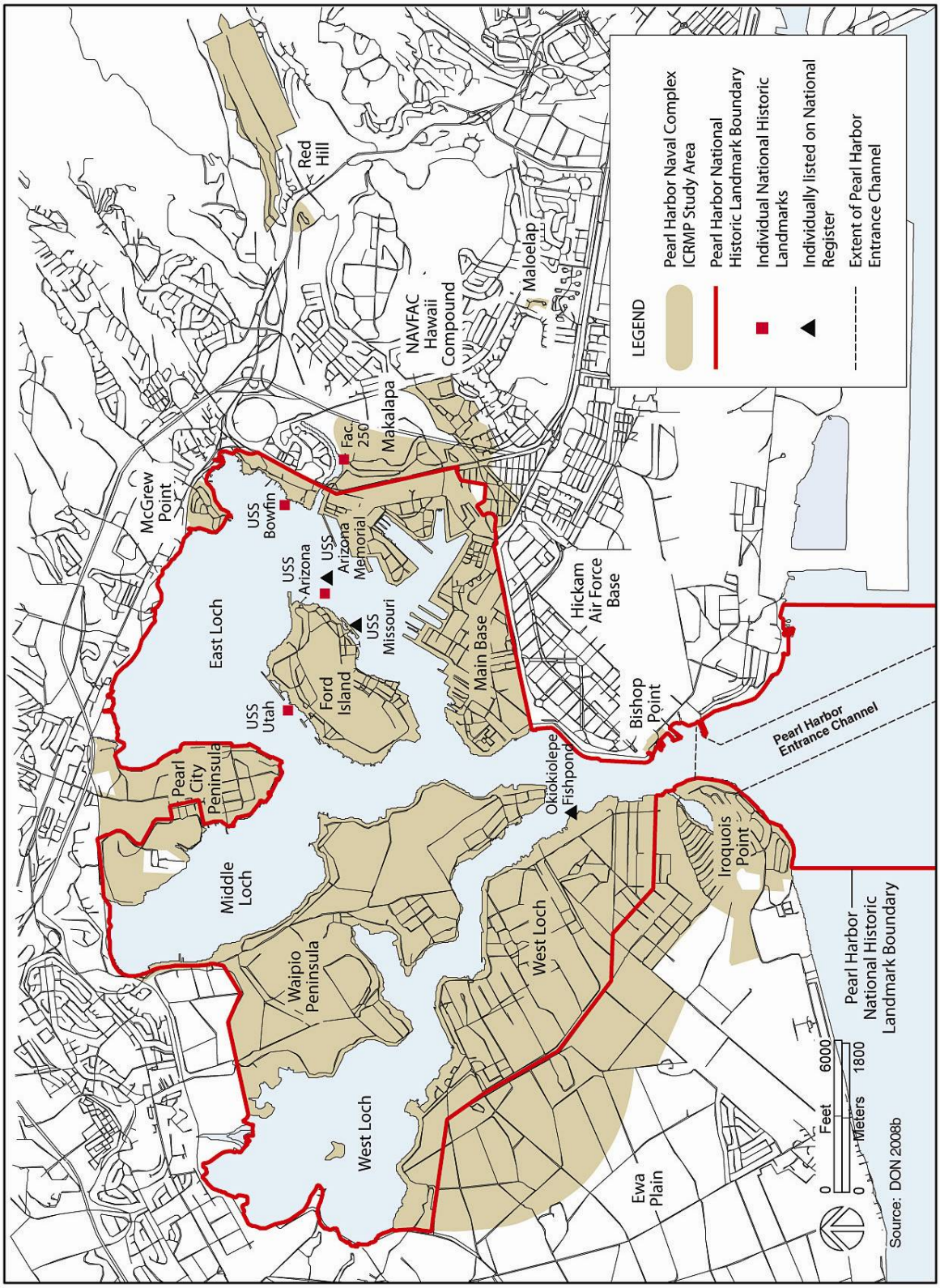


Figure 3-9: Pearl Harbor NHL and National Register Sites of PHNC

3.1.1.6 Regional Land Uses

As shown on Figure 3-10, the State Land Use Commission (LUC) has designated the majority of PHNC as within the State Urban District. Exceptions include Waipi'o Peninsula and portions of NAVMAG PH West Loch Branch within the ESQD arcs which are within the State Agricultural District. A small portion of Pearl City Peninsula in the vicinity of the PHNWR Waiawa Unit, is within the State Conservation District (SOH LUC 2009). As shown on Figure 3-11, the CCH has zoned the lands comprising PHNC as F-1 District (Federal and Military Preservation District). The PHNC is bordered by a variety of urban zoning districts including various industrial, commercial and residential districts, as well as agricultural and preservation zoning districts (CCH 2008).

3.2 GENERAL PHYSICAL ENVIRONMENT

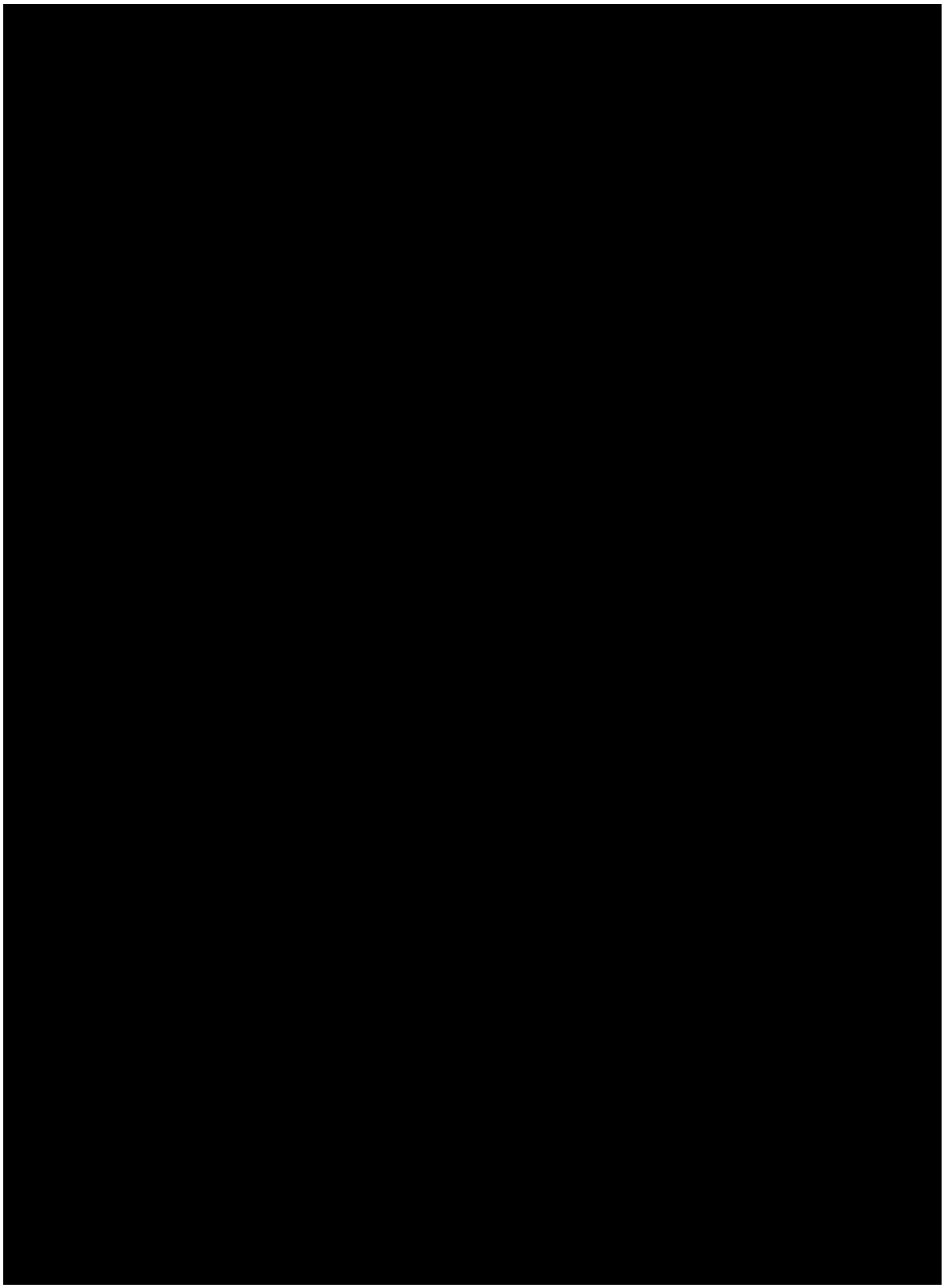
The discussion of the general physical environment is divided into six subsections (3.2.1 through 3.2.6): (1) physical geography; (2) topography; (3) climate; (4) geology; (5) soils; and (6) hydrology – including surface water resources and hydrogeology (groundwater resources).

3.2.1 Physical Geography

Section 2.2.1 provides a description of the physical geography of the Hawaiian Islands and the island of O'ahu. The majority of PHNC lies on O'ahu's coastal plain. However, Makalapa Crater and the Makalapa and Little Makalapa Housing Communities as well as the FFD are located in a volcanic crater formed from post-erosional volcanics of the Ko'olau Volcano. The Red Hill Storage Area, the Waiawa Watershed, the Halawa Housing Community, the Manana Housing Community, and the Red Hill Housing Community are located on the erosional slopes/aprons/fans of the Ko'olau Volcano.

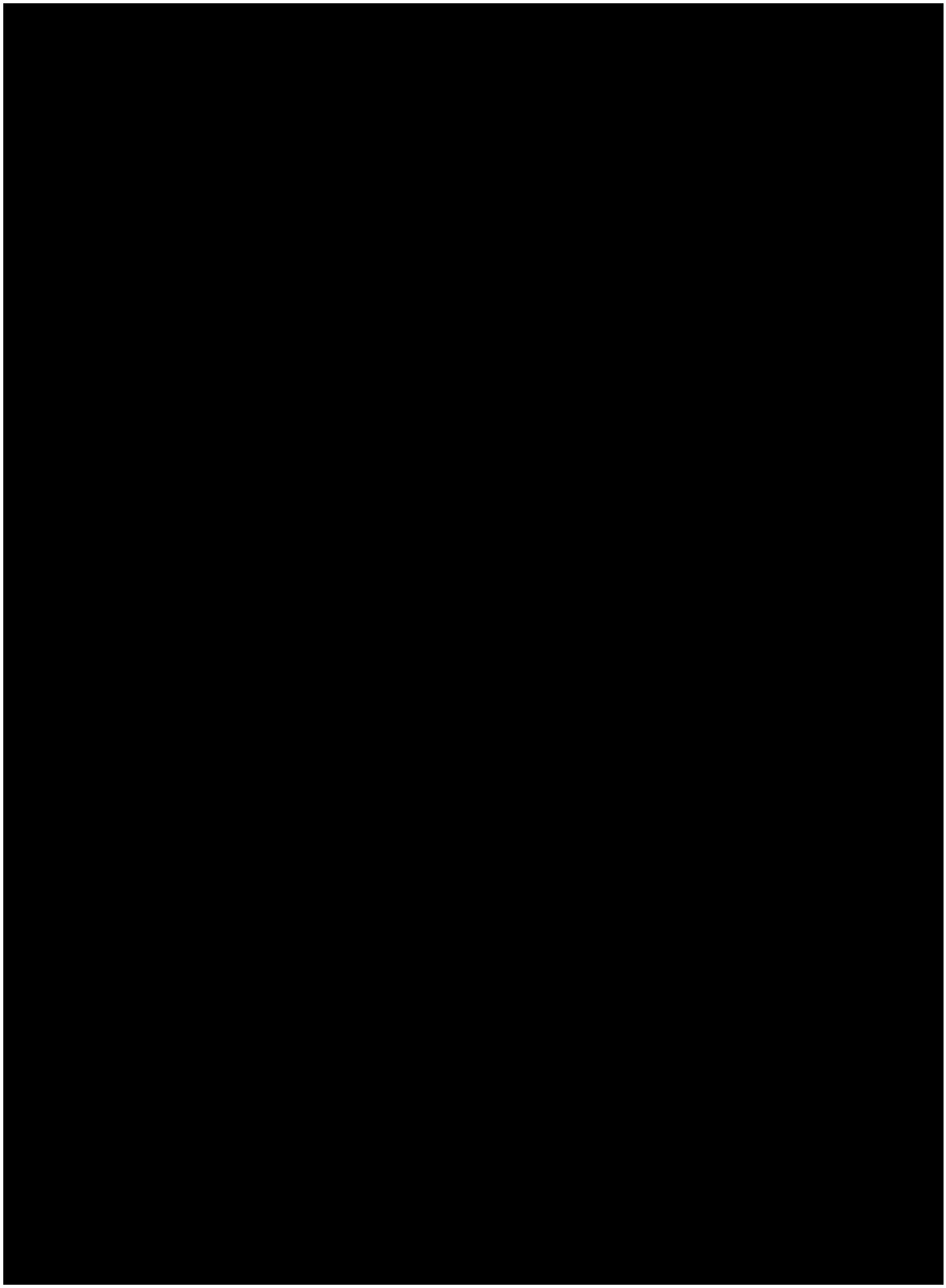
3.2.2 Topography

Section 2.2.2 provides a description of the topography of the island of O'ahu. Figures 3-12 to 3-14 provide topographic map coverage for PHNC. The majority of land adjacent to the PHNC waterfront is very flat and low-lying. Nearly all of Ford Island and Pearl City Peninsula have ground elevations of less than 20 ft (6 m) above mean sea level (msl). Topography rises away from the harbor, across Kamehameha Highway (Figure 3-13). The eastern portion of the main base area has a maximum elevation of 80 ft (24 m) above msl at the rim of Makalapa Crater. The Red Hill Storage Area, Waiawa Watershed, Halawa Housing Community, Manana Housing Community, and Red Hill Housing Community, which are located on the erosional slopes/aprons/fans of the Ko'olau Volcano, have higher elevations than the rest of PHNC. Topography is not a major factor or development constraint within the PHNC.



Redaction:Defense Critical Security Information Statute 10 U.S.C. § 130e

Figure 3-10: Regional Land Use in the Vicinity of Pearl Harbor, O'ahu



Redaction:Defense Critical Security Information Statute 10 U.S.C. § 130e

Figure 3-11: County Zoning in the Vicinity of Pearl Harbor, O'ahu

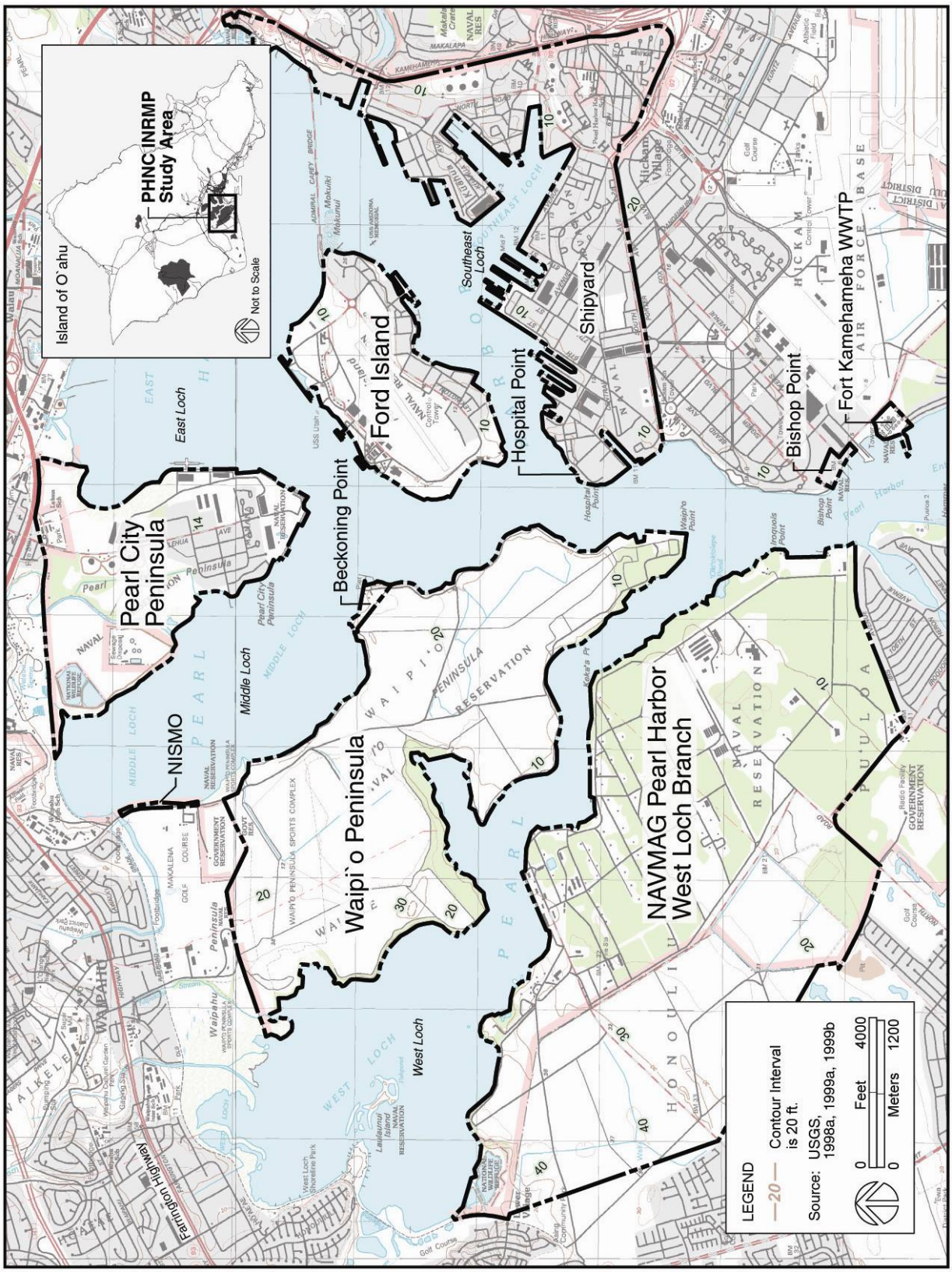


Figure 3-12: Topography, PHNC Study Area (Western Portion)

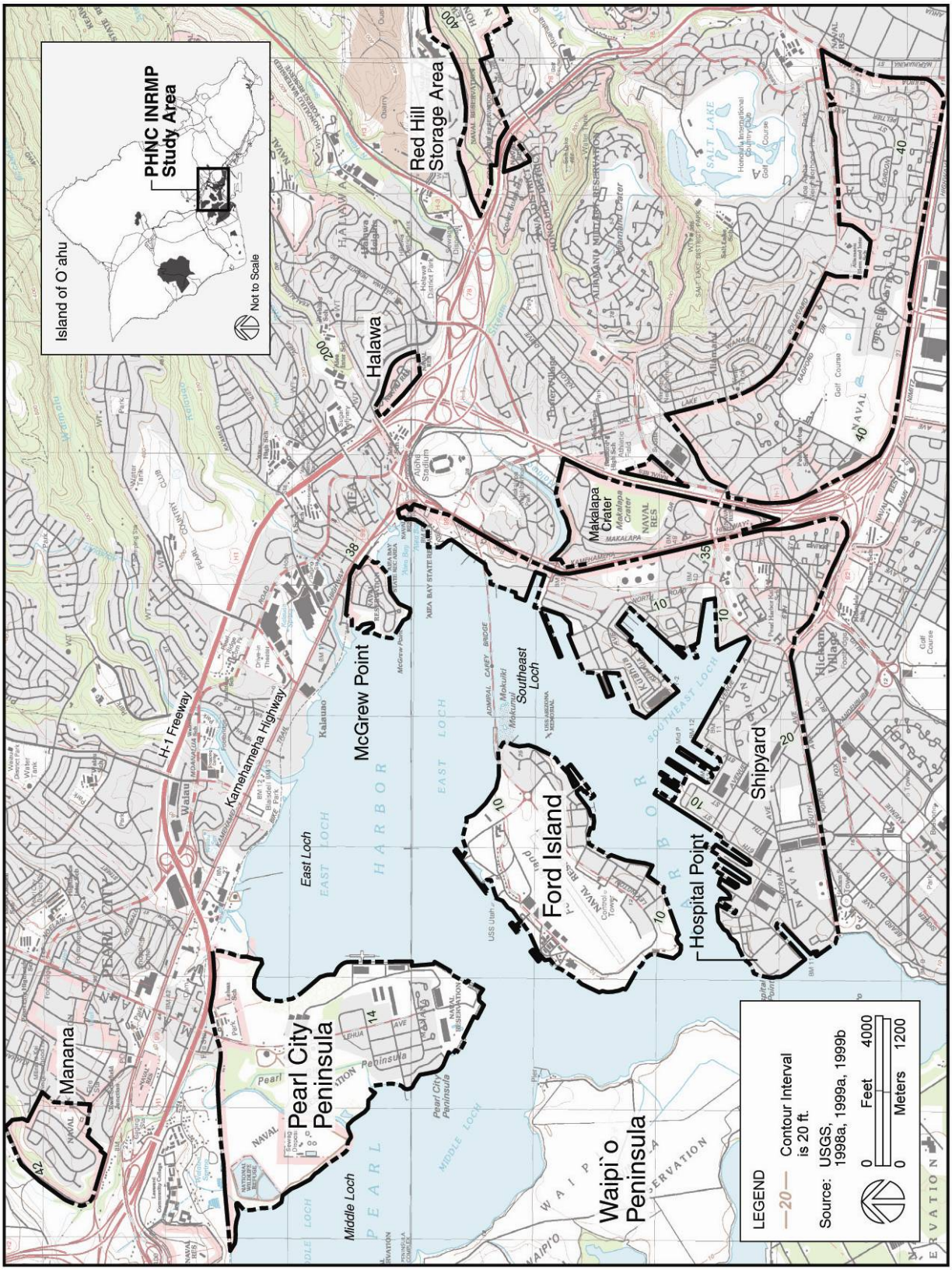


Figure 3-13: Topography, PHNC Study Area (Eastern Portion)

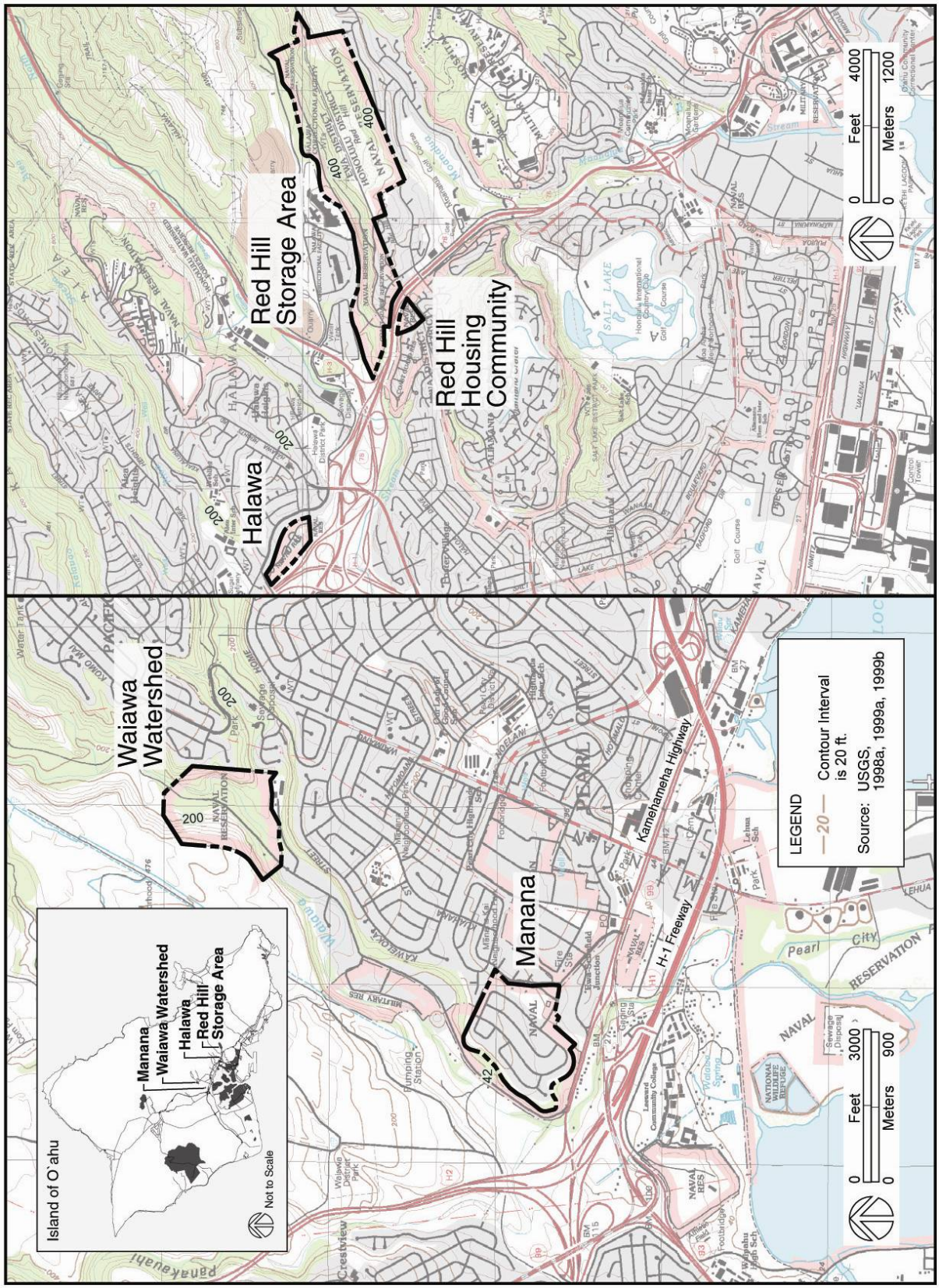


Figure 3-14: Topography, PHNC Study Area (Outlying Portions)

3.2.3 Climate

Section 2.2.3 provides a description of the climate of the Hawaiian Islands and the island of O'ahu. Temperatures vary by season as well as diurnally in the Pearl Harbor region. Highs of 87° to 89° Fahrenheit (F) (30.5° to 32°Celsius [C]) are not unusual during mid-afternoon in summer. Night temperatures during the same season fall between 72° and 76°F (22° and 26° C) and night time lows may reach the high 50's° or low 60's° F. The lows are generally caused by a shallow blanket of cold air that pours down from the mountains and spreads out over the low lands during periods of low velocity tradewind regimes. The low temperatures are almost invariably accompanied by heavy dew, which is not normal to the region (DON 2001a). Table 3-2 provides temperature ranges for the PHNC Area from 1971 – 2000.

Table 3-2: Temperature Ranges in the PHNC Area

Month	Honolulu International Airport (°F [C°])		
	Maximum	Mean	Minimum
January	80.4 (26.9)	73.0 (22.8)	65.7 (18.7)
February	80.7 (27.1)	73.0 (22.8)	65.4 (18.6)
March	81.7 (27.6)	74.3 (23.5)	66.9 (19.4)
April	83.1 (28.4)	75.6 (24.2)	68.2 (20.1)
May	84.9 (29.4)	77.2 (25.1)	69.6 (20.9)
June	86.9 (30.5)	79.5 (26.4)	72.1 (22.3)
July	87.8 (31.0)	80.8 (27.1)	73.8 (23.2)
August	88.9 (31.6)	81.8 (27.7)	74.7 (23.7)
September	88.9 (31.6)	81.5 (27.5)	74.2 (23.4)
October	87.2 (30.7)	80.2 (26.8)	73.2 (22.9)
November	84.3 (29.3)	77.7 (25.4)	71.1 (21.7)
December	81.7 (27.1)	74.8 (23.8)	67.8 (20.0)
Annual	84.7 (29.3)	77.5 (25.3)	70.2 (21.2)

Source: USGS 2006. Data for 1971 – 2000

Rainfall in the Pearl Harbor region is light and normally inadequate to sustain lawns and other vegetation for much of the year. Occasional periods of heavy precipitation occur during times of southerly wind incidence and may cause heavy flooding due to the nature of the soils and the relatively level slopes. These heavy rains are generally island wide and occur principally during winter. Monthly median rainfall indicates peak rainfall between November and February, and lowest rainfall between March and September. The mean annual rainfall for the region lies between 20 and 30 in (50 to 76 cm) dependent upon the incidence of the occasional heavy southerly rains mentioned previously (DON 2001a). Table 3-3 provides rainfall ranges in the PHNC Area from 1971 – 2000.

The relative humidity of the PHNC region varies between lows of 58 to 60 percent and highs of 80 percent. The latter occur during periods of rainfall in mid-summer or on cold nights in mid-winter. The mean daily maximum falls in the 62 to 65 percent range. While not high, these humidity levels do cause bodily discomfort and promote corrosion of unprotected metal. Pan evaporation rates are in the range of 40 to 90 in (100 to 230 cm) per year. The extreme difference between rainfall and pan evaporation rates is indicative of a very dry, coastal climate.

Table 3-3: Rainfall Ranges in the PHNC Area

Month	Honolulu International Airport (in [cm])		Moanalua (in [cm])		Waiawa (in [cm])	
	Mean	Median	Mean	Median	Mean	Median
January	2.73 (6.93)	1.28 (3.25)	3.98 (10.11)	2.38 (6.05)	3.17 (8.05)	1.76 (4.47)
February	2.35 (5.97)	1.33 (3.38)	3.29 (8.36)	2.34 (5.94)	2.19 (5.56)	1.53 (3.89)
March	1.89 (4.80)	1.30 (3.30)	3.36 (8.53)	2.61 (6.63)	1.77 (4.50)	1.36 (3.45)
April	1.11 (2.82)	0.70 (1.78)	3.00 (7.62)	2.64 (6.71)	0.95 (2.41)	0.34 (0.86)
May	0.78 (1.98)	0.44 (1.12)	1.94 (4.93)	1.65 (4.19)	1.03 (2.62)	0.37 (0.94)
June	0.43 (1.09)	0.21 (0.53)	1.74 (4.42)	1.51 (3.84)	0.34 (0.86)	0.25 (0.64)
July	0.50 (1.27)	0.39 (0.99)	1.72 (4.37)	1.51 (3.84)	0.66 (1.68)	0.39 (0.99)
August	0.46 (1.17)	0.24 (0.61)	1.28 (3.25)	1.10 (2.79)	0.55 (1.40)	0.28 (0.71)
September	0.74 (1.88)	0.60 (1.52)	1.74 (4.42)	1.46 (3.71)	0.71 (1.80)	0.50 (1.27)
October	2.18 (5.54)	1.60 (4.01)	3.04 (7.72)	2.36 (5.99)	2.27(5.77)	1.34 (3.40)
November	2.27 (5.77)	0.98 (2.49)	3.68 (9.35)	2.83 (7.19)	2.77 (7.06)	1.42 (3.61)
December	2.85 (7.24)	1.48 (3.76)	4.30 (10.92)	3.43 (8.71)	3.56 (9.04)	2.93 (7.44)
Annual	18.29 (46.46)	17.23 (43.76)	33.07 (84.00)	31.92 (81.08)	19.97 (50.72)	19.21 (48.79)

Source: USGS 2006. Data for 1971 – 2000

3.2.4 Geology

Section 2.2.4 provides a description of the geology of the Hawaiian Archipelago and the island of O'ahu. Figure 3-15 provides a map of the generalized geology of the Pearl Harbor Watershed area. The following paragraphs summarize the geology of PHNC including: (a) areas with significant natural resource value; (b) highly developed and industrialized areas; and (c) Navy family communities.

1. Areas with Significant Natural Resource Value

Pearl Harbor

The Pearl Harbor basin is a drowned river system with several tributaries that form the three main lochs (West Loch, Middle Loch, and East Loch). These join to form a single channel entrance (PHEC). The geologic processes that formed Pearl Harbor include sea level fluctuations, stream erosion, alluvial deposits, and volcanism. During periods of sea-level transgression (rise) and regression (fall), marine and terrestrial sediments were deposited over lavas of the Ko'olau and Wai'anae Volcanoes (Stearns 1985).

The Pearl Harbor inlet or re-entrant was created by the banking of the younger Ko'olau lavas against the older Wai'anae lavas. Waikele (also known as Waikakalaua) and Waiawa Streams flowing off the Ko'olau Range cut these lavas. The streams were deflected southward, following the path of the lava flows. In addition, two other streams, formed from a high rain-belt with large drainage, entered the inlet cutting deep canyons into the hard basalt. At that time, the sea level was at a lower level or stand and these four streams flowed farther out to sea than Pearl Harbor. During the Ka'ena stand of the sea, the Pearl Harbor re-entrant was a broad unsheltered bay. At that time, a continuous reef was not built in the bay due to the large quantity of gravel and mud, delivered by the streams and tributaries, which suffocated existing coral reef growth (Stearns 1985).

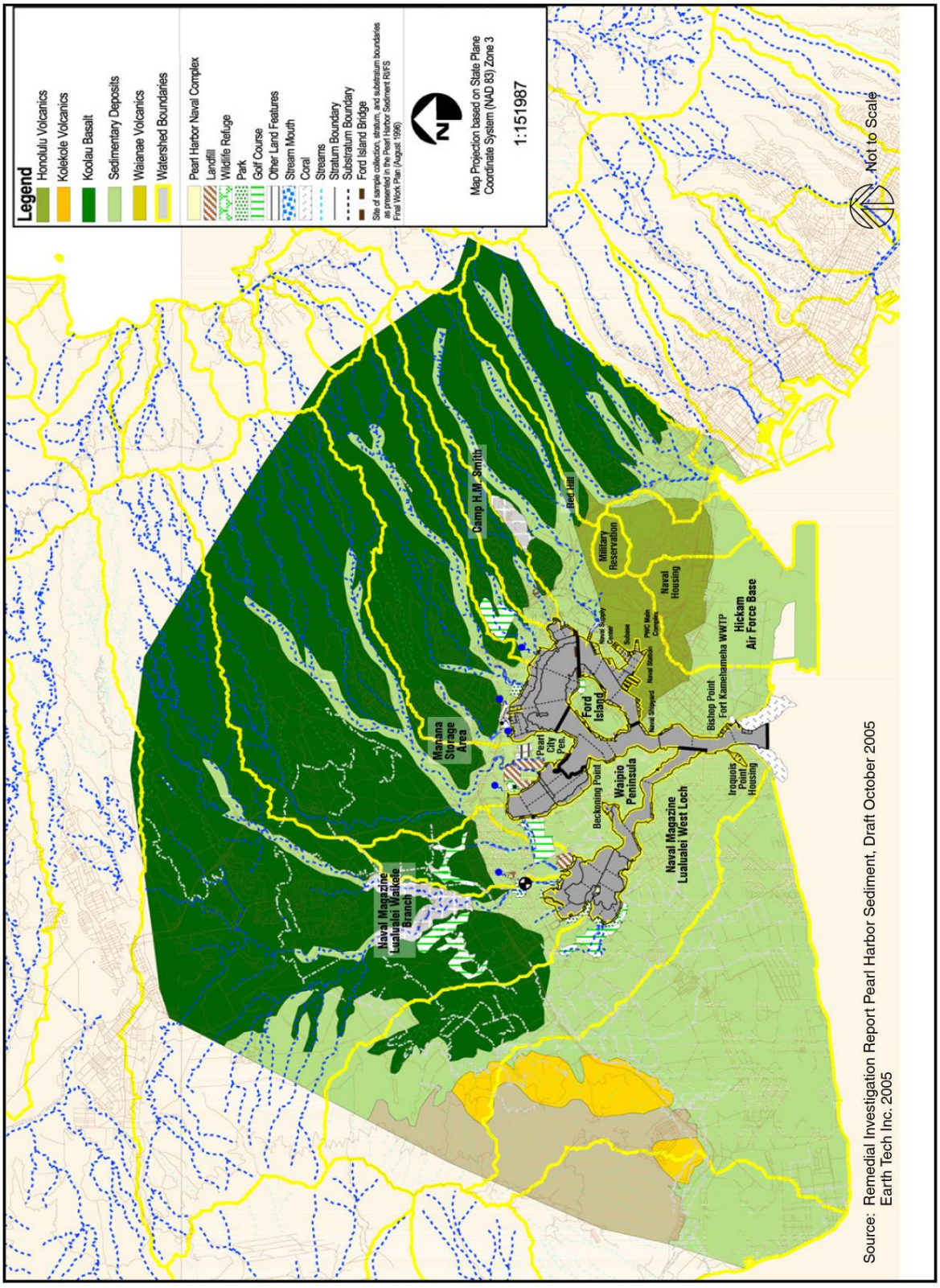


Figure 3-15: Generalized Geology, Pearl Harbor Area, O'ahu

Slowly, the sea retreated as the ice caps at the Earth's poles grew during the next glaciation, and, as a result, the sea fell approximately 350 ft (107 m), or more, lower than the present shoreline. During this time the rivers and tributaries re-established themselves and cut steep-sided deep valleys across the flat (the former broad embayment). During this time, Salt Lake Crater erupted and deposited several feet of well-bedded ash (tuff) over the area. Slowly, the sea level rose again as the glacial epoch ended and the valleys were again flooded with water levels reaching a height of 25 ft (8 m) above the present sea level. Oyster beds flourished in the drowned interstream divides, and thin coral reefs grew in stretches of clear water. Again the sea receded with the next glaciation (growth of the polar ice caps) and a new cycle of stream erosion began. The old valleys were cut again by the streams. Some of the reefs and associated deposits on the ancient interstream divides were washed into the sea. Caprock sediments overlie the Ko'olau basalts in some areas near the shoreline north of the harbor (Stearns 1985).

Makalapa Crater

Makalapa Crater, along with Salt Lake, and Aliamanu Craters, was formed approximately 0.5 million years ago by hydromagmatic explosions that occurred after the Ko'olau Range had been inactive for more than a million years and had become deeply eroded. These craters were formed from secondary eruptions and are part of the Honolulu Volcanic Series.

Pearl City Peninsula

Pearl City Peninsula, as well as Ford Island and Waipi'o Peninsula, represents an old interstream divide that was extended by reefs and sediments (Stearns 1985). The west side of Pearl Harbor, where Pearl City Peninsula, Waipi'o Peninsula, and Ford Island are located, is composed mostly of limestone reef material known as the 'Ewa Plain.

Red Hill Storage Area

The geological units of Red Hill Storage Area consist primarily of basaltic volcanic bedrock and volcanic alluvium derived from the Ko'olau Volcanic Series.

Waiawa Watershed

The Waiawa Watershed consists of an escarpment of solid bedrock about 100 ft (30 m) high on the east bank of the Waiawa Stream and an alluvial terrace on the opposite bank. The maximum thickness of the alluvial terrace is about 500 ft (152 m). The geological units of Waiawa Watershed consist primarily of basaltic volcanic bedrock from the Ko'olau Volcano and volcanic alluvium derived from eroded basalt which was transported by stream and sheet flow to the area.

West Loch/Waipi'o Peninsula

This ancient reef that comprises the 'Ewa Plain grew when sea level was up to 100 ft (30.8 m) higher than present. The consolidated limestone increases in thickness from 120 ft (37 m) at the northwest corner of NAVMAG PH West Loch Branch to 200 ft (61 m) near Iroquois Point, a change of only 80 ft (24 m) in over 2 mi (>3.2 km). The fossil reef is highly permeable and serves as an aquifer and filter. Below the reef, caprock, consisting of a complicated sequence of terrestrial and marine sediments, extends to the top of the basement rock, the Ko'olau basalt. The caprock basalt contact plunges from a depth of nearly 500 ft (152 m) below sea level at the Iroquois Point boundary. Waipi'o Peninsula is an old interstream divide within the coastal plain.

2. Highly Developed and Industrialized Areas

Waipi'o Peninsula, where Beckoning Point and NISMO are located, and Ford Island represent old interstream divides that were extended by reefs and sediments during the formation of Pearl Harbor and are considered part of the 'Ewa Coastal Plain. The ground surface at NAVMAG PH West Loch Branch is the top of a fossil reef association ('Ewa Coastal Plain) that has been consolidated into limestone.

Bishop Point, Fort Kamehameha WWTP, and the Shipyard are located within the Honolulu Coastal Plain. These areas are underlain by marine and terrestrial deposits as well as fill materials. Tuff deposits of the Honolulu Volcanic Series underlie FFD, MSC/NEX/Commissary, Naval Station, Navy-Marine Golf Course, Ohana Nui, the Public Works Center Compound, Richardson Recreation Center, and the Salt Lake Storage Area.

3. Navy Family Housing Communities

Tuff deposits of the Honolulu Volcanic Series underlie the Catlin Park, Doris Miller, Hale Moku, Halsey Terrace, Hokulani, Little Makalapa, Makalapa, Maloelap, Marine Barracks, Moanalua Terrace, and Radford Terrace Housing Communities.

Ford Island Housing Community is located on Ford Island and the Pearl City Peninsula Housing Community is located on Pearl City Peninsula. These areas represent old interstream divides created during the formation of Pearl Harbor and are part of the 'Ewa Coastal Plain. The Hospital Point Housing Community is located within the Honolulu Coastal Plain. The McGrew Point Housing Community is located within the 'Ewa Coastal Plain.

The Halawa, Manana, and Red Hill Housing Communities are located on alluvium derived from the Ko'olau Volcano and, at depth, are underlain by basic igneous rocks from the Ko'olau Volcanic Series.

3.2.5 Soils

The majority of the soils of PHNC reflect the geology of the region; however, several areas within PHNC are underlain by fill (USDA 1972). Figures 3-16 through 3-18 show the locations of soil types. Table 3-4 provides a summary of the soil types of PHNC.

3.2.5.1 Areas with Significant Natural Resource Value

Makalapa Crater

Makalapa Crater is underlain by rockland (rRK) and soils of the Hanalei Series, Kokokahi Series, and Makalapa Series (Figure 3-17 and Table 3-4). Areas of potential concern include portions of the crater underlain by Kokokahi very stony clay, 0 to 35 percent (KTKE) and Makalapa clay, 2 to 6 percent slope (MdB); these soils exhibit high shrink-swell potential and structures constructed on these materials can be susceptible to cracking. In addition, the KTKE soil type and the soils associated with rockland are characterized by moderate to severe erosion hazard (USDA 1972).

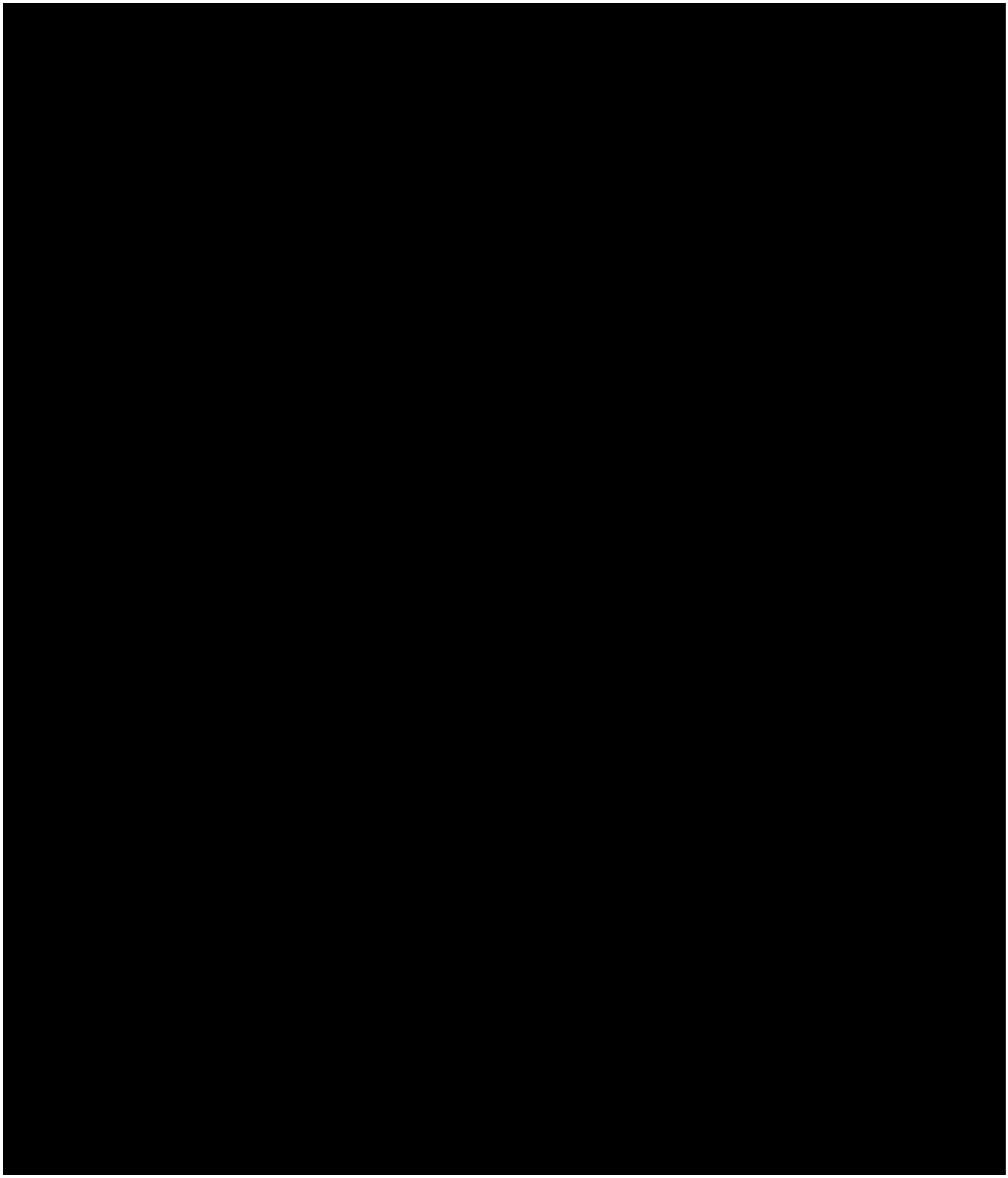


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Figure 3-16: Soils, PHNC Study Area (Western Portion)

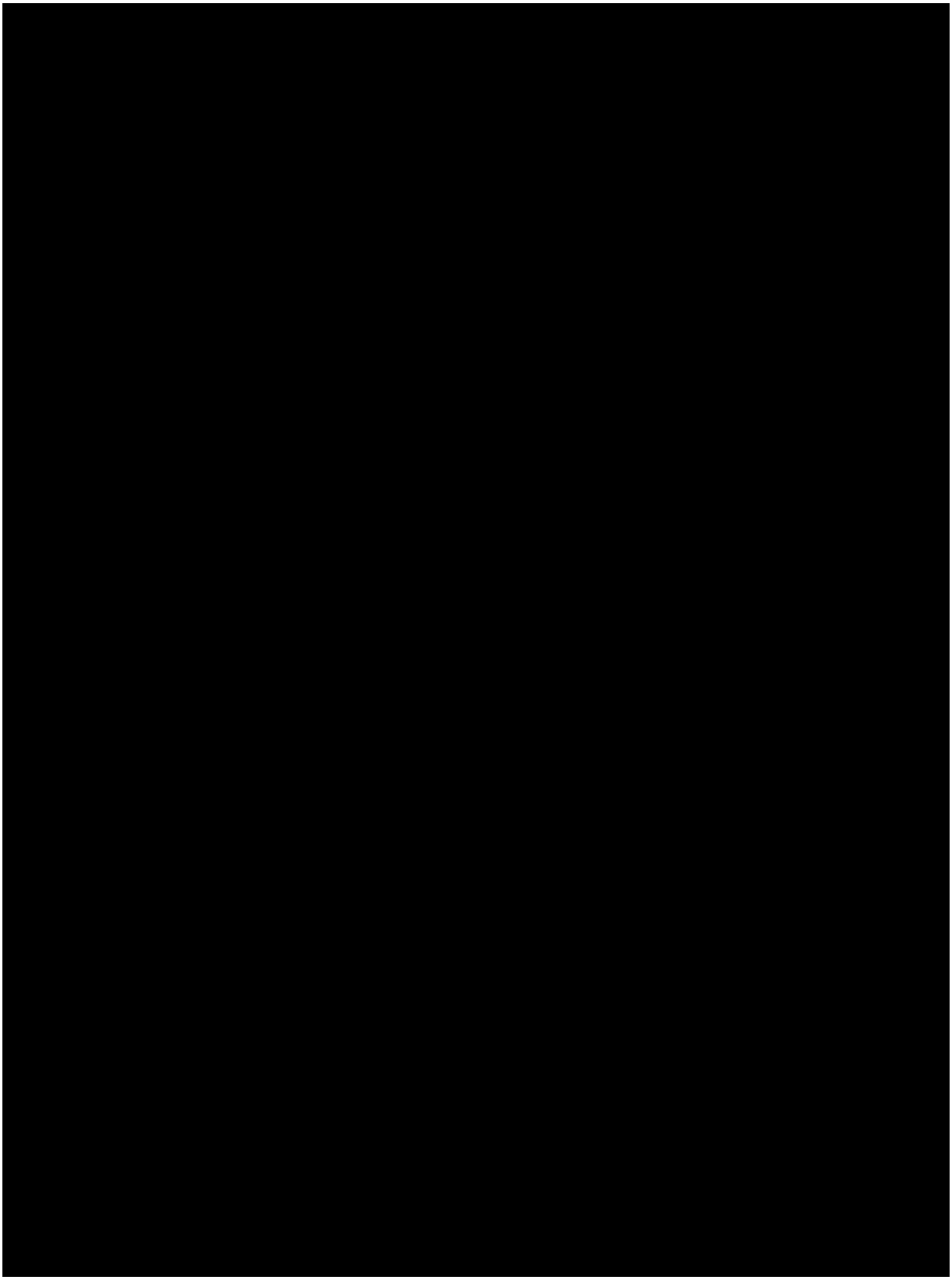

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Figure 3-17: Soils, PHNC Study Area (Eastern Portion)

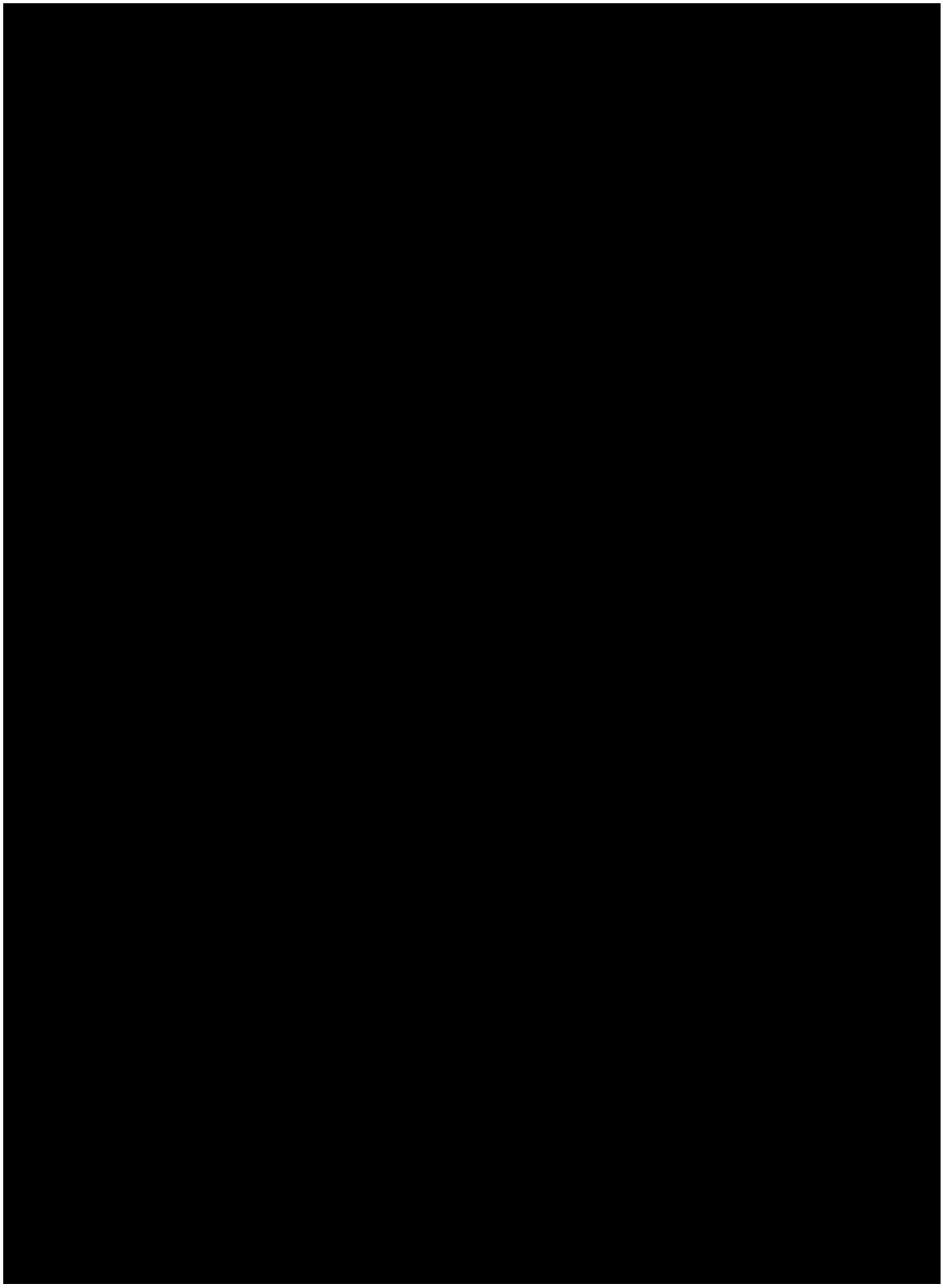

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Figure 3-18: Soils, PHNC Study Area (Outlying Portions)

Table 3-4: Summary of Soil Types for PHNC Study Area

Soil Type	Location	Description	Characteristics
Coral Outcrop (CR)	Small areas of CR are exposed on the ocean shore, on the coastal plains, and at the foot of the uplands. These soils can be found at Bishop Point, Ford Island (including housing areas), and Hospital Point Housing Community.	Composed of coral or cemented calcareous sand. In a typical profile, CR makes up about 80 to 90 percent of the acreage with the remaining 10 or 20 percent consisting of a thin layer of friable, red soil material in cracks, crevices, and depressions within the coral outcrop.	Soil characteristics were not reported for this soil type.
'Ewa Series: This series consists of well-drained soils in basins and on alluvial fans. These soils developed in alluvium derived from basic igneous rock.			
'Ewa silty clay loam, 3 to 6 percent slopes (EaB)	These soils can be found on alluvial fans and terraces, including portions of the Halawa Housing Community.	The surface layer is neutral, dark reddish-brown silty clay loam (~18 in [46 cm] thick). The subsoil is neutral, dark reddish-brown and dark red silty clay loam that has subangular, blocky structure (~42 in [107 cm] thick). The substratum is coral limestone, sand or gravelly alluvium.	Permeability is moderate, runoff is slow, and the erosion hazard is slight. The available water capacity is 1.3 in/ft (11 cm/m) in the surface layer and 1.4 in/ft (12 cm/m) in the subsoil.
'Ewa silty clay loam, moderately shallow, 0 to 2 percent slopes (EmA)	This soil type occurs on alluvial fans and terraces including portions of NAVMAG PH West Loch Branch.	The surface layer is dark reddish-brown silty clay loam about 18 in (45.7 cm) thick. The subsoil is dark reddish-brown and dark-red silty clay loam that has a subangular blocky structure. The substratum is coral limestone which can be found at 20 to 50 in (50.8 to 1227 cm) depth.	Permeability is moderate, runoff is very slow, and the erosion hazard is no more than slight. The available water capacity is 1.3 in/ft (11 cm/m) in the surface layer and 1.4 in/ft (12 cm/m) in the subsoil.
'Ewa silty clay loam, moderately shallow, 2 to 6 percent slopes (EmB)	This soil type occurs on alluvial fans and terraces including portions of NAVMAG PH West Loch Branch.	This soil is similar to EmA except for the slope.	Physical properties are the same as EmA.
Fill Land (Fd): This land type consists of areas filled with material from dredging, excavation from adjacent uplands, garbage, and bagasse and slurry from sugar mills. A few areas are filled with material from dredging and excavation. Generally, these materials are dumped and spread over marshes, low-lying areas along coastal flats, coral sand, coral limestone, or areas of shallow bedrock.			
Fill land, mixed (FL)	FL occurs mostly near Pearl Harbor and in Honolulu adjacent to the ocean. These soils occur at Pearl City Peninsula (including the housing community), Red Hill Storage Area, Naval Station, Public Works Center, Shipyard, and Marine Barracks Housing Community.	Areas filled with material dredged from the ocean or hauled from nearby areas, garbage, and general material from other sources.	Soil characteristics were not reported.
Halei'wa Series: Consists of well-drained soils on fans and in drainage ways along coastal plains. They developed in alluvium derived from basic igneous material.			

Table 3-4: Summary of Soil Types for PHNC Study Area (Continued)

Soil Type	Location	Description	Characteristics
Halei'wa silty clay, 2 to 6 percent slopes (HeB)	This soil type occurs as large areas on alluvial fans or as long narrow areas in drainage ways.	In a representative profile the surface layer is dark-brown silty clay about 17 in (43.2 cm) thick. The subsoil and substratum, to a depth of more than 5 ft (1.5 m), are dark brown and dark yellowish-brown silty clay that has subangular blocky structure. The soil is neutral to slightly acid.	Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.9 in/ft (15.8 cm/m).
Hanalei Series: This series consists of somewhat poorly drained to poorly drained soils on bottom lands. These soils develop in alluvium derived from basic igneous rock.			
Hanalei silty clay, 2 to 6 percent slopes (HnB)	This soil is found on stream bottoms and flood plains. These soils occur at Makalapa Crater.	The surface layer is about 10 in (25 cm) thick, dark-gray and very dark gray silty clay that has dark-brown and reddish mottles. The subsurface layer is very dark gray and dark-gray silty clay loam that has angular blocky structure. The substratum is stratified alluvium. The soil is strongly acid to very strongly acid in the surface layer and neutral in the subsoil.	Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available moisture capacity is about 2.1 in per ft (17.5 cm/m). Flooding is a hazard.
Helemano Series: This series consists of well-drained soils on alluvial fans and colluvial slopes on the sides of gulches. They developed in alluvium and colluvium derived from basic igneous rock.			
Helemano silty clay, 30 to 90 percent slopes (HLMG)	These soils can be found on the sides of V-shaped gulches including portions of Waiawa Watershed and Camp Stover Housing Community.	The surface layer is neutral, dark reddish-brown silty clay (~10 in [25 cm] thick). The subsoil (~50 in [127 cm] thick) is neutral to slightly acid, dark reddish-brown and dark-red silty clay that has subangular blocky structure. The substratum is soft, highly weathered basic igneous rock.	Permeability is moderately rapid. Runoff is medium to very rapid and the erosion hazard is severe to very severe. Available water capacity was not reported.
Honouliuli Series: This series consists of well-drained soils on coastal plains in the 'Ewa area. These soils developed in alluvium derived from basic igneous material.			
Honouliuli clay, 0 to 2 percent (HxA)	These soils occur on lowlands on coastal plains including portions of Pearl City Peninsula.	Neutral to moderately alkaline, dark reddish-brown, very sticky, very plastic in the surface layer (about 15 in [38 cm] thick). The subsoil and substratum are similar to the surface layer but have subangular blocky structure.	Permeability is moderately slow. Runoff is slow and the erosion hazard is no more than slight. The shrink-swell potential is high. The available water capacity is about 1.8 in/ft (15 cm/m).
Honouliuli clay, 2 to 6 percent slopes (HxB)	These soils occur on lowlands on coastal plains.	Neutral to moderately alkaline, dark reddish-brown, very sticky, very plastic in the surface layer (about 15 in [38 cm] thick). The subsoil and substratum are similar to the surface layer but have subangular blocky structure.	Permeability is moderately slow. Runoff is slow and the erosion hazard is slight. The shrink-swell potential is high. The available water capacity is about 1.8 in/ft (15 cm/m).

Table 3-4: Summary of Soil Types for PHNC Study Area (Continued)

Soil Type	Location	Description	Characteristics
Jaucas Series: This series consists of extensively drained, calcareous soils that occur as narrow strips on coastal plains, adjacent to the ocean.			
Jaucas sand, 0 to 15 percent slopes (JaC)	These soils occur on coastal plains including portions of Fort Kamehameha WWTP.	Neutral to moderately alkaline single grain, pale brown to very pale brown, sand (greater than 60 in [152 cm] thick). The surface layer can be dark brown as a result of accumulation of organic matter and alluvium.	Permeability is rapid, and runoff is very slow to slow. The water erosion hazard is slight but the wind erosion hazard is severe where vegetation has been removed. The available water capacity is about 0.5 to 1 in/ft (4 to 8 cm/m).
Ka'ena Series: This series consists of very deep, poorly drained soils on alluvial fans and talus slopes. These soils developed in alluvium and colluvium from basic igneous rocks.			
Ka'ena very stony clay, 10 to 35 percent slopes (KanE)	This soil occurs on talus slopes and alluvial fans including portions of Red Hill Storage Area.	There are many stones in this soil. The surface layer is very dark gray clay about 10 in (25 cm) thick. The next layer, 36 in (91 cm) to more than 48 in (122 cm) thick, is dark-gray and dark grayish-brown clay that has prismatic structure. It is underlain by highly weathered gravel.	Permeability is slow. Runoff is low to medium and the erosion hazard is slight to moderate. Workability is difficult because the soil is stony, steep, very sticky, and very plastic. The shrink-swell potential is very high. The available water capacity is about 1.7 in per ft (14.16 cm/m).
Kaloko Series: This series consists of poorly drained soils on coastal plains. These soils developed in alluvium derived from basic igneous rock; the alluvium has been deposited over marly lagoon deposits.			
Kaloko clay, noncalcareous variant (Kfb)	This soil occurs in slight depressions on the coastal plains including small portions of NAVMAG PH West Loch Branch.	The surface layer is very dark gray clay. The subsoil is gray or grayish-brown prismatic clay. The substratum is massive clay and silty clay. This soil is slightly acid to neutral throughout. It is more acid and grayer than is typical for the Kaloko series. It is underlain by noncalcareous material.	Permeability is slow. Runoff is ponded to very slow, and the erosion hazard is none to slight. The available water capacity is 1.6 in/ft (13.3 cm/m) of soil.
Kawaihāpai Series: This series consists of well-drained soils in drainageways and on alluvial fans on coastal plains. These soils formed in alluvium derived from basic igneous rock in humid uplands.			
Kawaihāpai stony clay loam, 0 to 2 percent slopes (KlaA)	These soils occur on smooth slopes including portions of Red Hill Storage Area.	Neutral, dark brown clay loam in the surface layer (about 22 in [56 cm] thick) with enough stones to hinder but not prevent cultivation. The next layer is neutral, dark-brown stratified sandy loam (about 32 in [81 cm] thick). The substratum is neutral, stony, and gravelly.	Permeability is moderate. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.8 in/ft (15 cm/m) in the surface layer and 1.6 in/ft (13 cm/m) in the subsoil. Workability is slightly difficult due to stoniness.
Kawaihāpai stony clay loam, 2 to 6 percent slopes (KlaB)	These soils occur on smooth slopes including portions of Red Hill Storage Area and Waiawa Watershed.	Similar in profile to KlaA.	Similar in characteristics as KlaA.

Table 3-4: Summary of Soil Types for PHNC Study Area (Continued)

Soil Type	Location	Description	Characteristics
Kawaihāpai very stony clay loam, 0 to 15 percent slopes (KlaC)	These soils occur in narrow drainageways including portions of Red Hill Storage Area and Waiawa Watershed.	Similar in profile to KlaA except that there are enough stones to prevent cultivation.	Similar in characteristics as KlaA except that runoff is medium and erosion hazard is moderate.
Kawaihāpai silty clay loam, 2 to 7 percent slopes (KlcB)	These soils occur on smooth slopes including portions of Red Hill Storage Area.		
Kea'au Series: This series consists of poorly drained soils on coastal plains. These soils developed in alluvium deposited over reef limestone or consolidated coral sand.			
Kea'au clay, 0 to 2 percent slopes (KmA)	These soils occur on lowlands on coastal plains including portions of Pearl City Peninsula (containing the housing community), Beckoning Point, and Halsey Terrace Housing Community.	This soil is mildly alkaline, very dark grayish-brown clay about 15 in (38 cm) thick in the surface layer. The subsoil (about 19 in [48 cm] thick) is moderately alkaline, very dark grayish-brown and dark brown, mottled clay that has subangular and angular blocky structure. The substratum is moderately alkaline, white to very pale brown reef limestone, or consolidated coral sand. The water table is at a depth of 1.5 to 3 ft (0.5 to 1 m).	Permeability is slow, runoff is slow, and the erosion hazard is no more than slight. The shrink-swell potential is high. The available water capacity is 1.5 in/ft (13 cm/m).
Kea'au clay, saline, 0 to 2 percent slopes (KmbA)	This soil occurs on lowlands on the coastal plains.	This soil has a profile like that of KmA except that there are sufficient stones to hinder machine cultivation.	Permeability is slow, runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.5 in/ft (12.5 cm/m). The shrink-swell potential is high.
Kea'au stony clay, 0 to 2 percent slopes (KmaB)	This soil occurs on lowlands on the coastal plains including small portions of NAVMAG PH West Loch Branch.	This soil has a profile similar to KmA except that there are sufficient stones in this soil type to hinder machine cultivation.	This soil is similar to KmA except that the erosion hazard is slight.
Kokokahi Series: This series consists of moderately well-drained soils on talus slopes and alluvial fans. These soils developed in colluvium and alluvium derived from basic igneous rock.			
Kokokahi very stony clay, 0 to 35 percent slopes (KTKE)	These soils occur on talus slopes and alluvial fans including portions of Makalapa Crater (including the housing community).	All layers contain many stones and boulders. The surface layer is slightly acid to neutral, very dark gray clay (~14 in [36 cm] thick). The next layer (about 12 in [31 cm] thick) is slightly acid to moderately alkaline, dark grayish-brown clay that has a subangular blocky structure. The substratum is slightly acid to moderately alkaline, grayish-brown, and light grayish-brown clay (14 to 20 in [36 to 51 cm] thick).	These soils are very sticky and very plastic and they crack widely upon drying. Permeability is slow to moderately slow. Runoff is medium to rapid and the erosion hazard is moderate to severe. The shrink-swell potential is high. The available water capacity is 1.6 in/ft (13 cm/m).
Lāhainā Series: This series consists of well-drained soils on uplands. These soils developed in material weathered from basic igneous rock.			

Table 3-4: Summary of Soil Types for PHNC Study Area (Continued)

Soil Type	Location	Description	Characteristics
Lāhainā silty clay, 7 to 15 percent slopes (LaC)	These soils occur on smooth uplands including portions of Red Hill Storage Area and Red Hill Housing Community.	Medium acid dark reddish-brown, silty clay in the surface layer (~15 in [38 cm] thick). The subsoil is slightly acid to medium, dusky-red and dark reddish brown subangular blocky silty clay and silty clay loam (~45 in [114 cm] thick). The substratum is slightly acid to medium acid, soft, weathered basic igneous rock.	Permeability is moderate. Runoff is medium and erosion hazard is medium. Available water capacity is 1.3 in/ft (11 cm/m) in the surface layer and 1.4 in/ft (12 cm/m) in the subsoil.
Lāhainā silty clay, 7 to 15 percent slopes, severely eroded (LaC3)	These soils occur on smooth uplands including portions of the Red Hill Housing Community.	Similar in profile to LaC except the surface layer and, in places, part of the subsoil has been removed by erosion.	Similar in characteristics to LaC except that runoff is medium and the erosion hazard is severe.
Makalapa Series: This series consists of well-drained soils on uplands near Salt Lake Crater.			
Makalapa Clay, 2 to 6 percent slopes (MdB)	These soils occur on gently sloping areas near Salt Lake Crater including portions of Makalapa Crater (including the housing community), FFD, MSC/NEX/Commissary, Naval Station, Navy-Marine Golf Course, Ohana Nui, Public Works Center, Richardson Recreation Center, Salt Lake Storage Area as well as Catlin Park, Doris Miller Park, Hale Moku, Halsey Terrace, Hokulani, Little Makalapa, Makalapa, Maloelap, Marine Barracks, and Moanalua Terrace Housing Communities.	This soil is mildly alkaline, dark grayish-brown clay about 8 in (20 cm) thick. The next layer (18 to 36 in [46 to 91 cm] thick) is mildly to moderately alkaline, very dark grayish-brown, weathered volcanic tuff.	The clays are very sticky and very plastic and they crack upon drying. Permeability is slow, runoff is slow, and the erosion hazard is slight. The shrink-swell potential is high. Available water capacity is 1.4 in/ft (12 cm/m).
Makalapa Clay, 6 to 12 percent slopes (MdC)	These soils occur on alluvial fans including portions of the Halsey Terrace, Maloelap, Moanalua Terrace, and Radford Terrace Housing Communities.	Similar in profile to MdC except that it occurs on alluvial fans	Similar in characteristics as MdB.
Makalapa Clay, 12 to 20 percent slopes (MdD)	These soils occur on smooth uplands including portions of Moanalua Terrace.	Similar in profile to MdB.	Similar in characteristics as MdB except that runoff is medium and the erosion hazard is moderate.
Māmala Series: This series consists of shallow, well-drained soils along the coastal plains. These soils formed in alluvium deposited over coral limestone and consolidated calcareous sand.			

Table 3-4: Summary of Soil Types for PHNC Study Area (Continued)

Soil Type	Location	Description	Characteristics
Māmala stony silty clay loam, 0 to 12 percent slopes (MnC)	These soils occur on coastal plains including portions of Pearl City Peninsula, Beckoning Point, and Fort Kamehameha WWTP.	Neutral to mildly alkaline, dark reddish-brown stony silty clay loam in the surface layer (~ 8 in [20 cm] thick). The subsoil is neutral to mildly alkaline, dark reddish-brown silty clay loam (~11 in [28 cm] thick). The soil is underlain by coral limestone and consolidated calcareous sand at depths of 8 to 20 in (20 to 51 cm). Stones, mostly coral rock fragments, are common in the surface layer and in profile.	Permeability is moderate. Runoff is very slow to medium and the erosion hazard is slight to moderate. The available water capacity is 2.2 in/ft (18 cm/m) in the surface layer and 1.9 in/ft (16 cm/m) in the subsoil.
Mānana Series: This series consists of well-drained soils on uplands. These soils developed in material weathered from basic igneous rock.			
Mānana silty clay loam, 12 to 25 percent slopes, eroded (MpD2)	These soils occur on smooth slopes including portions of Red Hill Storage Area.	The surface layer is strongly acidic, dark reddish-brown silty clay loam (8 in [20 cm] thick). The subsoil (about 42 in [107 cm] thick) is strongly to extremely acidic, dusky-red, dark reddish-gray, and dark reddish-brown silty clay that has subangular blocky structure. A nonporous, pan-like sheet (0.125 to 0.25 in [0.32 to 0.64 cm] thick) occurs in the subsoil at less than 15 in (38 cm). The substratum is strongly to extremely acidic, soft, weathered basic igneous rock.	Permeability is moderately rapid above the pan and moderate below. Runoff is rapid, and the erosion hazard is severe. The available water capacity is 1.2 in/ft (10 cm/m) in the surface layer and 1.3 in/ft (11 cm/m) in the subsoil.
Mānana silty clay loam, 6 to 12 percent slopes (MoC)	These soils occur on smooth slopes including portions of Red Hill Storage Area.	Similar to MpD2 except that the depth of the pan ranges from 15 to 50 in (38 to 127 cm).	Similar in characteristics as MpD2 except that runoff is medium and the erosion hazard is moderate.
Moloka'i Series: This series consists of well-drained soils on uplands. These soils formed in material weathered from basic igneous rock.			
Moloka'i silty clay loam, 3 to 7 percent slopes (MuB)	These soils occur on smooth slopes including portions of the Manana Housing Community.	Slightly acidic to neutral, dark reddish-brown silty clay loam in the surface layer (~15 in [38 cm] thick). The subsoil is slightly acidic to neutral, dark reddish-brown silty clay loam that has prismatic structure (~57 in [145 cm] thick). The material at depths of 35 to 64 in (89 to 163 cm) is moderately compact in place. The substratum is slightly acidic to neutral, soft, weathered rock.	Permeability is moderate. Runoff is slow and the erosion hazard is slight. Available water capacity is 1.3 in/ft (11 cm/m).

Table 3-4: Summary of Soil Types for PHNC Study Area (Continued)

Soil Type	Location	Description	Characteristics
Moloka'i silty clay loam, 3 to 7 percent slopes, severely eroded (MuC)	These soils occur on knolls and sharp slope breaks including portions of the Manana Housing Community.	A profile like MuB except that the surface layer and, in places, part of the subsoil have been removed by wind and water erosion.	Similar in characteristics as MuB except that runoff is moderate and erosion hazard is severe.
Mokulē'ia Series: Consists of well-drained soils along the coastal plains. These soils formed in recent alluvium deposited over coral sand. They are shallow and nearly level.			
Mokulē'ia clay (Mtb)	This soil occurs as small areas on the coastal plains.	It is nearly level. In a representative profile the surface layer is very dark grayish-brown clay about 16 in (40.6 cm) thick. The next layer, about 34 to 48 in (86.4 to 121.9 cm) thick, is dark-brown and light-gray, single grain sand and loamy sand. The material is moderately alkaline.	Permeability is slow in the surface layer and rapid in the subsoil. Runoff is very slow and the erosion hazard is no more than slight. The available water capacity is 1.8 in/ft (15 cm/m) in the surface layer and about 1.0 in/ft (8.3 cm/m) in the subsoil. Workability is difficult due to the sticky, plastic clay.
Pearl Harbor Series: This series consists of very poorly drained soils on nearly level coastal plains. These soils developed in alluvium overlying organic material.			
Pearl Harbor clay (Ph)	These soils occur on coastal plains including portions of Pearl City Peninsula and NISMO.	Neutral, very dark gray, mottled clay in the surface layer (about 12 in [31 cm] thick). The subsoil (about 19 in [48 cm] thick) is mildly to moderately alkaline, very dark gray and very dark grayish-brown, mottled clay that has angular and subangular blocky structure. The substratum is muck or peat.	Permeability is very slow. Runoff is very slow to ponded, and erosion hazard is no more than slight. Available water capacity is about 1.4 in/ft (12 cm/m).
Rockland (rRK)	This soil type includes exposed rock covering 25 to 90 percent of the surface and can be found at Makalapa Crater and Red Hill Storage Area.	The rock outcrops and very shallow soils are the main characteristics. The rock outcrops are mainly basalt and andesite.	In many areas, the soil material associated with the rock outcrops is very sticky and very plastic. It also has high shrink-swell potential. Buildings on the steep slopes are susceptible to sliding when the soil is saturated. Foundations and retaining walls are susceptible to cracking.
Tropaquepts (TR)	These soils are poorly drained and are periodically flooded by irrigation in order to grow crops that thrive in water. These soils have been flooded for varying lengths of time, and soil development differs in degree from place to place. They occur at portions of the McGrew Point Housing Community.	The surface layer (~10 in [25 cm] thick) consists of dark-gray, soft, mucky silt loam. This layer overlies firm to compact silty clay loam (~5 to 10 in [13 to 25 cm] thick), that is mottled with gray, yellow, and brown. The mottled layer overlies friable alluvium.	No characteristics reported.
Waipahu Series: This series consists of well-drained soils on terraces. These soils developed in old alluvium derived from basic igneous rock.			

Table 3-4: Summary of Soil Types for PHNC Study Area (Continued)

Soil Type	Location	Description	Characteristics
Waipahu silty clay, 0 to 2 percent slopes (WzA)	These soils occur on dissected terraces adjacent to the ocean including portions of the Halawa Housing Community.	The surface layer is slightly acidic, grayish-brown silty clay (~12 in [31 cm] thick). The subsoil is slightly acidic, dark brown silty clay that has prismatic structure (~58 in [147 cm] thick) and is very sticky and very plastic in the lower part. The substratum is clayey alluvium.	Permeability is moderately slow. Runoff is slow or very slow and the erosion hazard is none to slight. Available water capacity is about 1.4 in/ft (12 cm/m) in the surface layer and 1.6 in/ft 13 cm/m) in the subsoil.
Waipahu silty clay, 2 to 6 percent slopes (WzB)	This soil occurs on dissected terraces adjacent to the ocean including portions of the Manana Housing Community	In a representative profile the surface layer is grayish-brown silty clay about 12 in (30.5 cm) thick. The subsoil, about 58 in (147.3 cm) thick, is dark-brown silty clay that has prismatic structure. It is very sticky and very plastic in the lower part. The substratum is clayey alluvium. The soil is slightly acidic in the surface layer and subsoil.	Permeability is moderately slow. Runoff is slow and the erosion hazard is slight. Available water capacity is about 1.4 in/ft (12 cm/m) in the surface layer and 1.6 in/ft 13 cm/m) in the subsoil.
Waipahu silty clay, 6 to 12 percent slopes (WzC)	These soils occur on dissected terraces adjacent to the ocean including areas at NISMO and McGrew Point Housing Community.	Similar in profile to WzA.	Similar in profile to WzA except that runoff is medium and the erosion hazard is moderate.

Sources: USDA 1972 and NRCS 2007

Pearl City Peninsula

Pearl City Peninsula is underlain by soils of the Honouliuli Series, Kea'au Series, Māmala Series, and the Pearl Harbor Series as well as Fill Land (Figure 3-17 and Table 3-4). Areas of concern include portions of the peninsula underlain by the Honouliuli clay, 0 to 2 percent (HxA) and Kea'au clay, 0 to 2 percent slopes (KmA), which have a high shrink-swell potential. In addition, portions of the peninsula are underlain by Pearl Harbor clay (Ph), which is characterized by ponded water (USDA 1972).

Red Hill Storage Area

Most of Red Hill Storage Area (Photo 3-8) consists of steep slopes along a narrow ridge. Several large areas of erosion were observed on the ridge at Red Hill by NAVFAC PAC biologists in the fall of 2006. A significant portion of the ridge is eroded, primarily due to vegetation loss from human activities, including vehicle maneuvering, parking, etc. Topsoil has been lost through wind erosion and new vegetation has not been reestablished. The existing vegetation prevents soil loss and provides watershed protection. NAVFAC PAC biologists recommend that the eroded areas be revegetated

Photo 3-8: Soil erosion at Red Hill Fuel Storage Area

with native groundcover species ('ūlei, a'ali'i, 'iliahi) as it is unlikely to do so without human intervention (NAVFAC PAC 2006i) (Section 9.4).

Red Hill Storage Area is underlain by rRK as well as fill materials and soils of the Lāhainā Series, Mānana Series, Kawaihāpai Series, and Ka'ena Series (Figure 3-18 and Table 3-4). Soils of the Mānana silty clay loam, 12 to 25 percent slopes (MpD2), are characterized by severe erosion hazard and soils of the Ka'ena very stony clay, 10 to 35 percent slopes (KanE), have high shrink-swell potential (USDA 1972).

Waiawa Watershed

Waiawa Watershed is underlain by soils of the Kawaihāpai Series and Helemano Series (Figure 3-18 and Table 3-4). Helemano silty clay, 30 to 90 percent slopes (HLMG), is characterized by severe to very severe erosion hazard (USDA 1972).

West Loch/Waipi'o Peninsula

There are no known soil stabilization or erosion problems at the NAVMAG PH West Loch Branch that require action. Figure 3-16 shows the soil types for the installation and Table 3-4 provides a description of these soil types. Portions of the installation underlain by soils of the Helemano Series (e.g. HLMG) have a severe to very severe erosion hazard and soils of the Honouliuli Series and Kea'au Series have a high shrink-swell potential (USDA 1972). Although there are heavy sediment loads deposited into West Loch of Pearl Harbor estuary after rains, the sediments originate in the upper portion of the watershed where civilian activities predominate. In the vicinity of Pearl Harbor, where military controlled lands prevail, the topography is level to gently sloping.

3.2.5.2 Highly Developed and Industrialized Areas

Figures 3-16 to 3-18 shows the soil types for the PHNC land areas. Table 3-4 provides a description of each soil type. Beckoning Point, FFD, MSC/NEX/Commissary, Naval Station, Navy-Marine Golf Course, Ohana Nui, Public Works Center, Richardson Recreation Center, and Salt Lake Storage Area are underlain or partially underlain by KmA, soils of the Makalapa Series, and/or rRK, which are characterized by high shrink-swell potential. Fort Kamehameha WWTP is partially underlain by Jaucas sand, 0 to 15 percent slopes (JaC), which is characterized as having a severe wind erosion hazard. NISMO is underlain by Ph which is characterized by ponded water. In addition, the soils associated with rockland are characterized by moderate to severe erosion hazard (USDA 1972).

3.2.5.3 Navy Family Housing Communities

Figures 3-16 through 3-18 shows the soil types for the PHNC land areas. Table 3-4 provides a description of each soil type. Catlin Park, Doris Miller Park, Hale Moku, Halsey Terrace, Hokulani, Hospital Point, Little Makalapa, Makalapa, Maloelap, Manana, Marine Barracks, Moanalua Terrace, and Radford Terrace are underlain or partially underlain by KmA, soils of the Makalapa Series, Moloka'i Series, and/or rRK which are characterized by high shrink-swell potential. Pearl City Peninsula Housing Community is underlain by Ph which is characterized by ponded water. In addition, the KTKE soil type (Makalapa Housing Community), Lāhainā silty clay, 7 to 15 percent slopes, severely eroded (LaC3) (Red Hill Housing Community), and the soils associated with rRK are characterized by moderate to severe erosion hazard (USDA 1972).

3.2.6 Hydrology

Section 2.2.5 provides a description of the hydrology of the Hawaiian Islands and the island of O'ahu. The discussion of the PHNC hydrology is divided into three subsections: (1) surface water resources; (2) hydrogeology (groundwater resources); and (3) aquifer characteristics.

3.2.6.1 Surface Water Resources

1. Pearl Harbor Watershed

Figure 3-19 provides a pictorial view of the Pearl Harbor Watershed. The 110 mi^2 (285 km^2) of overall watershed for Pearl Harbor is subdivided into nine distinct subwatersheds: (1) 'Aiea; (2) Hālawa; (3) Honouliuli; (4) Kalauao; (5) Kapakahi; (6) Waiawa; (7) Waikele; (8) and Waimalu (Waimalu and Waimano Streams) (Figure 3-20). These watersheds contain the headwaters of nine streams that drain into Pearl Harbor.

The Pearl Harbor Watershed is characterized by a very steep precipitation gradient from the harbor to the crest of the Ko'olau Range. Although the Pearl Harbor area is relatively dry with a mean annual rainfall of 25.5 in (64.8 cm), the crest of the Ko'olau Range and other mountainous regions within the watershed are considerably wetter with a mean annual rainfall that can exceed 275 in (699 cm). Rainfall is seasonal, varying from 4 in (10.2 cm) per month during the winter (December to February) to 1 in (2.54 cm) per month during the summer (June to July) (Earth Tech Inc. 2005). The volume of freshwater entering Pearl Harbor has been estimated at 50 million gallons per day (mgd) (189 million liters per day [mld]) during dry periods and greater than 100 mgd (379 mld) during rainy periods (Cox and Gordon 1970 and B-K Dynamics 1972 in DON 2001a).

On the coastal plain, perennial flow may originate from basal groundwater springs. 'Aiea, Hālawa, Kalauao, Waimalu, and Waimano Streams drain steep, relatively narrow valleys of the Ko'olau Range and, therefore, transport substantial coarse sediment loads during storm events. Waikele and Honouliuli Streams drain the Schofield Plateau and typically transport large amounts of fine-grained sediment. The Waikele Watershed is largest and comprises 40 percent of the overall Pearl Harbor Watershed and discharges the heaviest sediment load of any of the Pearl Harbor Basin streams (Grovhoug 1992 in DON 2001a). All streams drain forested and agricultural lands and pass through highly urbanized areas before entering Pearl Harbor.

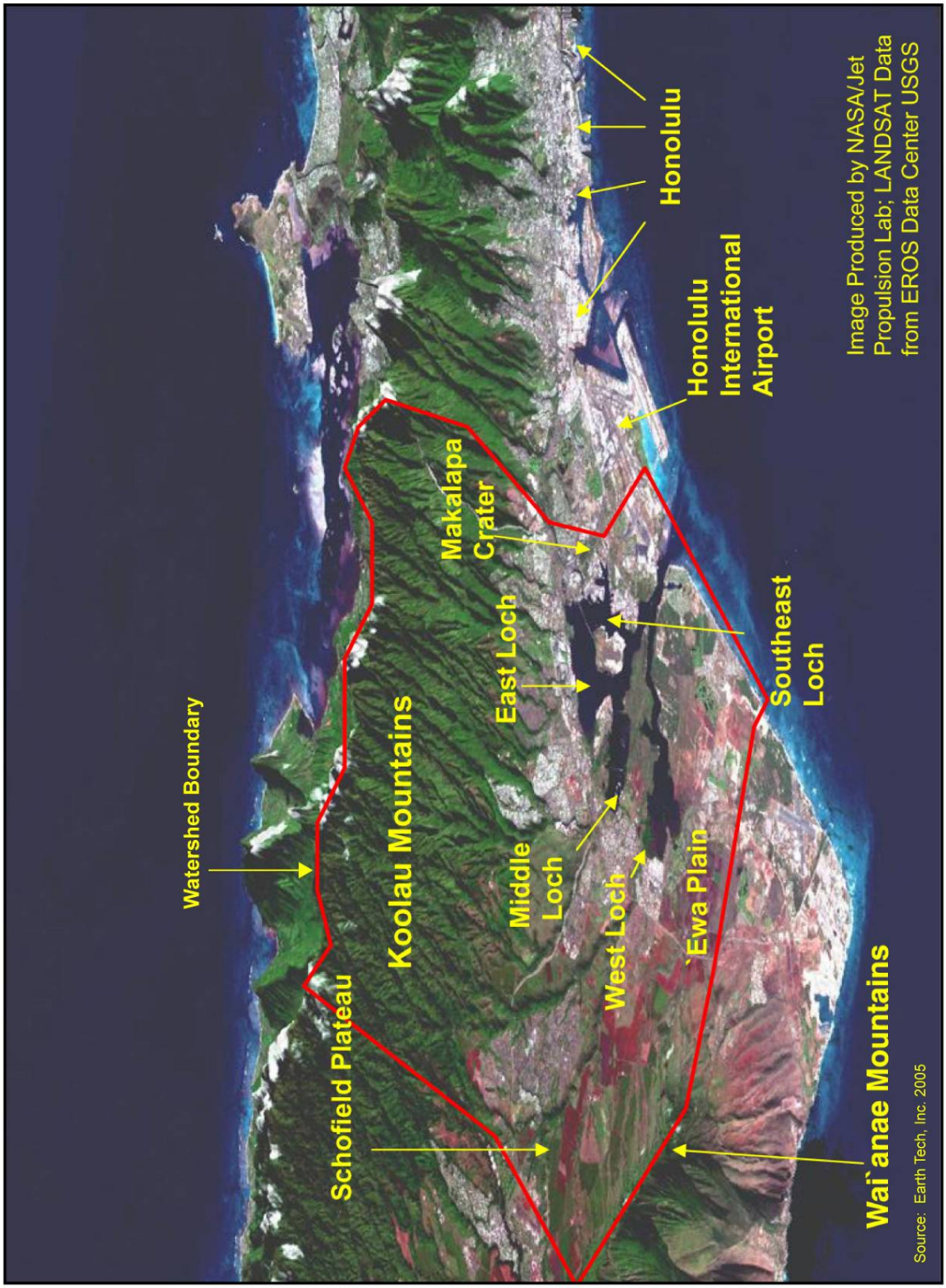

Figure 3-19: Aerial View of Pearl Harbor Watershed and Southern O'ahu

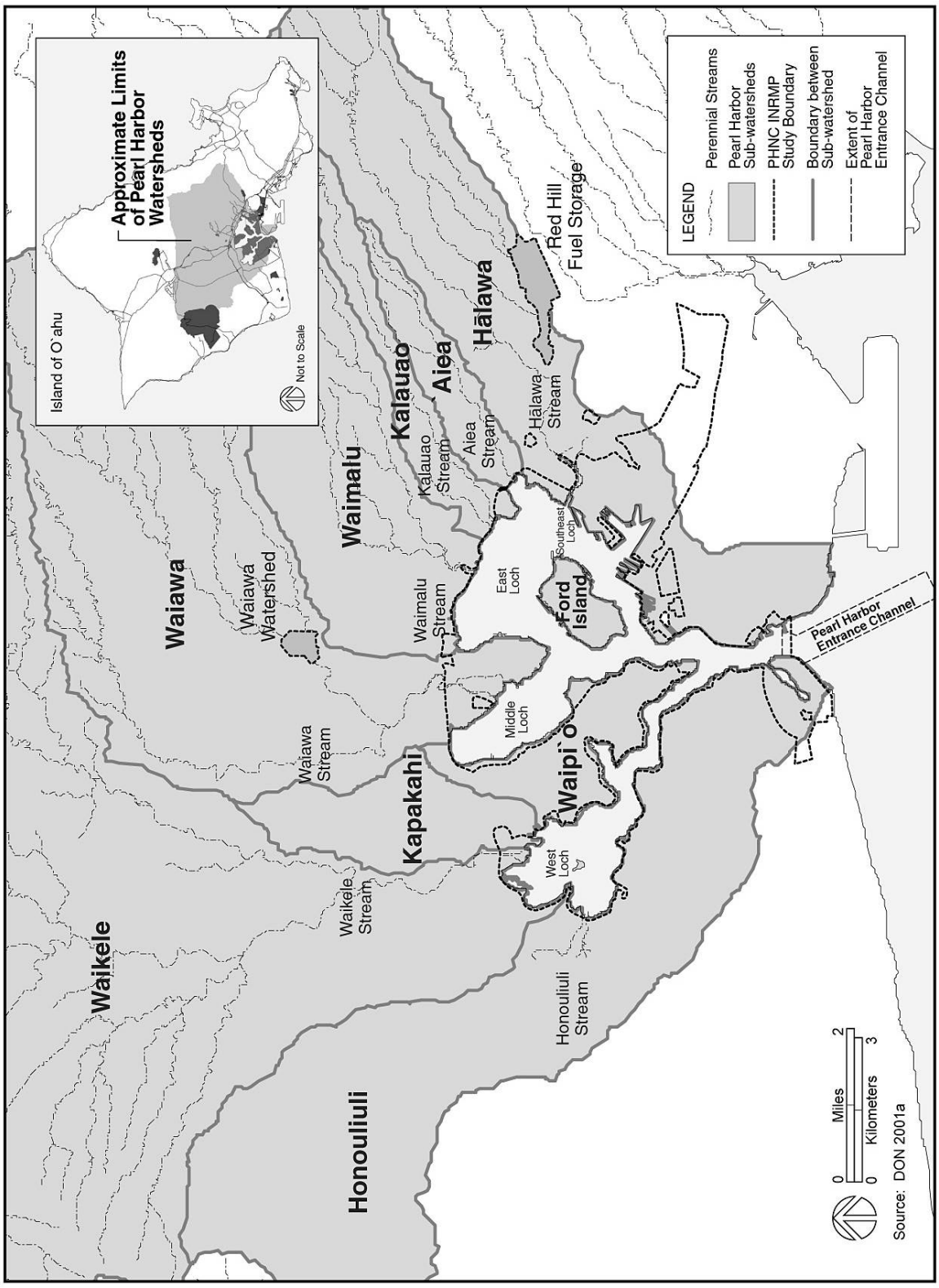

Figure 3-20: Pearl Harbor Watershed, Subwatersheds, and Perennial Streams

2. Streams

Stream flow constitutes approximately 8 mgd (30 mld) of freshwater into the harbor during dry periods and 56 mgd (212 mld) during wet periods. Approximately 40 percent of the stream runoff entering the harbor enters into Middle Loch, another 40 percent enters into West Loch, and only 20 percent enters into East Loch. Hālawa, 'Aiea, Kalauao, Waimalu, Honouliuli, Waiawa, and Waikele streams are perennial (year-round) streams that flow into the Pearl Harbor estuary. In addition, several intermittent streams and springs also flow into the harbor. These perennial and intermittent streams drain agricultural and urban lands before passing through highly urbanized lands near the harbor. Stream water is fresh up until a short distance upstream from the mouth of the streams where they enter into the saline waters of the estuary. High flood peaks and low base flow above the areas of spring influence characterize Pearl Harbor streams.

3. Springs

Five large springs heavily influence the stream flows into Pearl Harbor: (1) Waikele; (2) Waiawa; (3) Waimanu; (4) Waiau; and (5) Kalauao. These springs are located along the shoreline and are considered the largest and most significant spring complex in the Hawaiian Islands. The largest spring is the Waimanu-Waiau Spring which drains into East Loch; it has a median flow of 32 mgd (121 mld). The springs issue from points along the edge of the upper confining member of the aquifer and represent overflow of the artesian basin rather than artesian springs. Spring discharges have increased in the past 10 years because sugarcane cultivation and its associated irrigation water pumping has ceased. Stream flow into the harbor contributes 31 mgd (117 mld) during dry periods and 87 mgd (329 mld) during wet periods and heavily influences the harbor water chemistry and associated marine biological conditions of the harbor (Earth Tech Inc. 2005).

4. Pearl Harbor Estuary

Pearl Harbor is the SOH's largest estuary, a coastal area where fresh water from rivers and streams mix with salt water from the ocean. Borders of Pearl Harbor include wetland, marsh, and swamp habitat, where siltation is a significant on-going process. The SOH DOH classifies the waters of the harbor as an inland estuary, Class 2. The objective of Class 2 water is to protect their use for recreational purposes, propagation of fish and other aquatic life, and agricultural and industrial water supplies, shipping, navigation, and propagation of shellfish. Discharges into Class 2 waters must receive the best degree of treatment or control compatible with the criteria established for this class (SOH DOH 2004).

Like all estuaries, Pearl Harbor is a natural sediment trap, and is the ultimate "recipient" of the contaminant load from many sources within the watershed. It is estimated that approximately 96,300 tons (180,000 cubic yards or 137,500 cubic meters) of sediment per year is delivered to Pearl Harbor from basin streams (Grovhoug 1992 in DON 2001a). Pearl Harbor has been identified by DOH as one of eighteen "Water Quality-Limited Segments" (WQLS) around the State. After heavy rains, the nearshore waters of the harbor often turn red from the sediment-laden runoff. This sediment discharge is due primarily to poor erosion and sediment control in upland areas—along stream banks, unstable slopes, and cleared land (e.g., agricultural land, urban construction sites). Heavy metals and other chemical contaminants (e.g., pesticides, herbicides, etc.) frequently adsorb to sediment particles and are transported to the harbor waters. These contaminants can adversely impact the marine ecosystem. Although the Navy is required by law to meet SOH and federal water quality standards in Pearl Harbor, it has little control over activities in the watershed that impact water quality.

Point source discharges are defined by SOH DOH as discharges that enter a body of water from a specific, identifiable point such as a pipe, ditch, tunnel, channel, or similar discrete conveyance (SOH DOH 2004). The DOH issues National Pollutant Discharge Elimination System (NPDES) permits for discharges into Pearl Harbor. There are two sources of continual point source discharge: (1) secondary treated effluent from Fort Kamehameha WWTP through an outfall into PHEC; and (2) cooling effluent from HECO's Waiau Power Plant. In addition to these continual sources, there are dozens of other NPDES permits, both individual and general permits that have been issued for occasional or intermittent discharges into Pearl Harbor.

The USEPA placed Pearl Harbor on the National Priorities List in 1992. The Navy, in cooperation with USEPA, DOH, USFWS, NOAA Fisheries, and members of the public, have conducted a Remedial Investigation (RI) of the harbor. Toxicity tests have identified areas of concern in Southeast Loch, Middle Loch, West Loch, and the PHEC. In 1998, DOH issued an advisory warning that humans should not consume fish and shellfish caught in Pearl Harbor, posted warning signs in various locations around the harbor, and published multilingual brochures warning of possible health effects associated with eating fish and shellfish from the harbor. Although the RI has identified areas of the harbor for clean up, Pearl Harbor continues to receive runoff and pollutants from 22 percent of the land area of O'ahu including former and existing agricultural lands, urban areas, and commercial and light industrial areas.

5. Flooding

Flood Insurance Rate Maps (FIRM) for PHNC (Federal Emergency Management Agency [FEMA] 2011) indicate that the majority of PHNC is located in Zone D ("areas of undetermined, but possible, flood hazards") (Figure 3-21). Portions of PHNC are located in Zone A, Zone AE, Zone AH, Zone AO, Zone VE, and Zone X. Zone A is in the 100 year base flood zone with no depth of base elevations determined; Zone AE is in the 100-year base flood zone with elevations determined; Zone AH is in the 100-year flood zone with shallow flooding, usually in the form of a pond, with an average depth of 1 to 3 ft (0.3 m to 0.9 m); Zone AO includes river and stream flood hazard areas and in the 100-year floods zone with an average depth of 1 to 3 ft (0.3 m to 0.9 m); Zone VE includes coastal areas within the 100-year flood zone which have an additional hazard associated with storm waves. Zone X is outside the 500-year flood zone (FEMA 2011). Small portions of PHNC are located in the 500-year flood hazard zone (FEMA 2011). With the exeption of Ford Island, the majority of nearshore areas at PHNC are located in tsunami evacuation zones (CCH 2010).

3.2.6.2 Hydrogeology

Section 2.2.5 describes the four major aquifer types that occur at PHNC and other parts of O'ahu. Unconfined near-surface caprock groundwater resides in sediments that overlie and confine groundwater at lower levels within the basaltic bedrock that underlies the Pearl Harbor area. The caprock groundwater occurs in permeable sediments (sands and gravels) that overlie

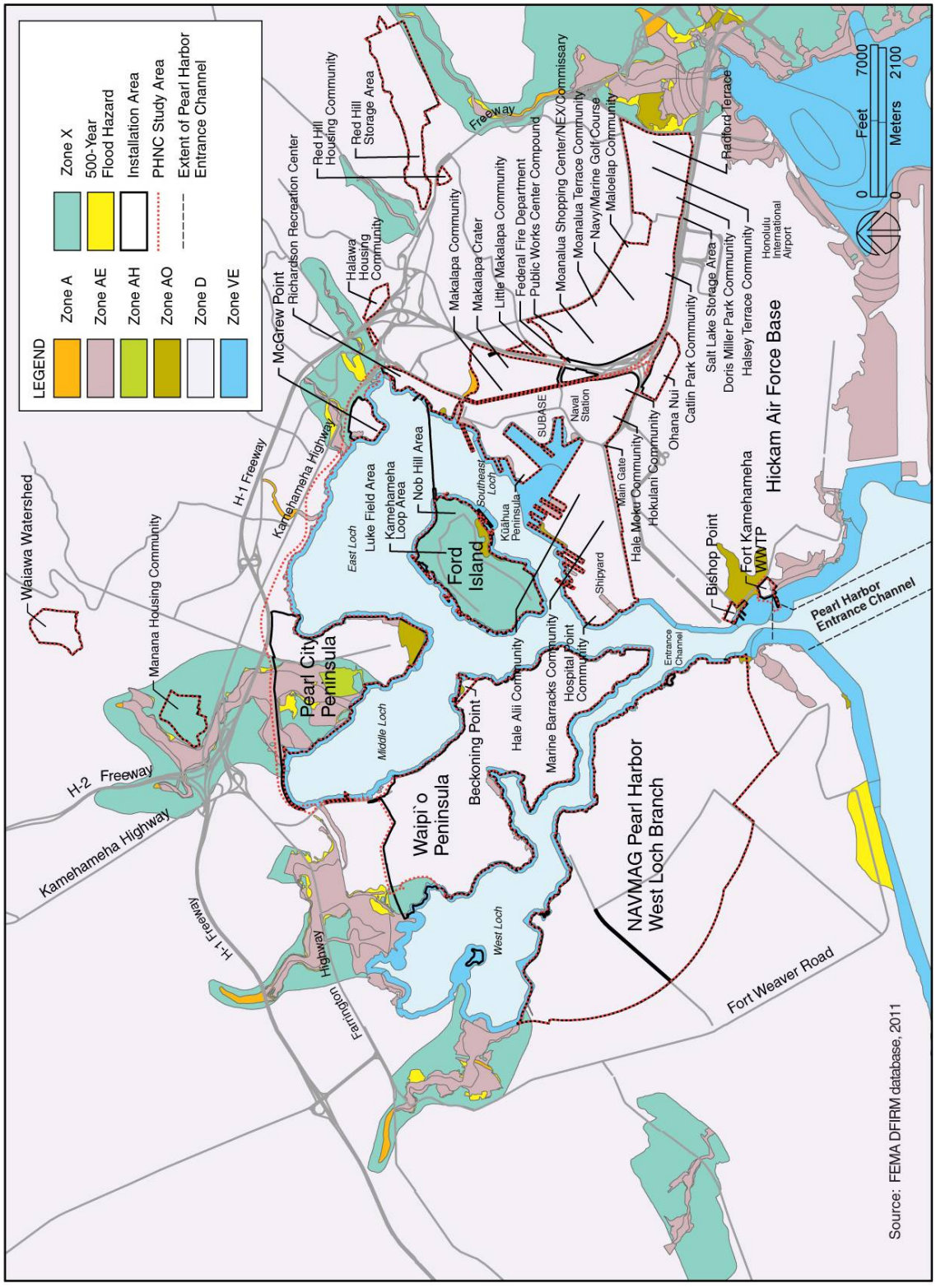

Figure 3-21: FEMA Flood Zones, PHNC Study Area

impermeable sediments (clays) that confine the deeper groundwater within the underlying fractured basalts. The caprock groundwater is recharged by water that infiltrates the near-surface sediments and percolates downward to the saturated zone below the water table. Both the near-surface caprock groundwater and the deeper, confined groundwater flow toward the ocean, and are recharged by infiltration from rainfall, streams, and irrigation. In the northern Pearl Harbor area, groundwater discharge supports the perennial stream flows and springs, while farther to the south, groundwater within the confined Ko'olau basalt aquifer exists under artesian conditions and discharges to Pearl Harbor or the ocean.

Groundwater flow toward Pearl Harbor may act as a transport pathway for chemicals present in upland soils to reach the harbor. Chemicals present in upland soils may enter the groundwater by leaching through highly permeable overlying soils except in areas overlain by sedimentary caprock. Once in the groundwater, chemicals may be transported to streams that discharge to the harbor or the harbor directly.

Table 3-5 presents a summary of the aquifer characteristics for PHNC. As indicated in Table 3-5, there are four aquifers that are currently used for drinking water within PHNC (Mink and Lau 1990); these are further described below.

- Basal, unconfined, flank aquifer of the Waimalu Aquifer System of the Pearl Harbor Aquifer Sector (30201111[11111]); it underlies Red Hill Storage Area, Public Works Center Compound, and the Halawa Housing Community. There are Navy potable water supply wells located at Red Hill Storage Area and adjacent to the Halawa Housing Community.
- Basal, unconfined, flank aquifer of the Waiawa Aquifer System of the Pearl Harbor Aquifer Sector (30202111 [11111]); it underlies Little Makalapa, Makalapa, and Manana Housing Communities.
- Basal, confined, flank aquifer of the Moanalua Aquifer System of the Honolulu Aquifer Sector (30104121 [11113]); it underlies Ohana Nui and the Hoku Lani Housing Community.
- Basal, unconfined, flank aquifer of the Moanalua Aquifer System of the Honolulu Aquifer Sector (30104111 [11111]); it underlies a portion of Red Hill Storage Area, Waiawa Watershed, FFD, MSC/NEX/Commissary, Navy-Marine Golf Course, Public Works Center Compound, and Salt Lake Storage Area, Catlin Park, Doris Miller, Halsey Terrace, Maloelap, Moanalua Terrace, Radford Terrace Housing Communities.

Table 3-5: Summary of PHNC Aquifer Characteristics

Aquifer Code	Aquifer Sector	Aquifer System	Aquifer Type	Development Stage/Utility/Salinity	Uniqueness*/Vulnerability to Contamination
30201116 (12211)	Pearl Harbor	Waimalu	Basal unconfined sedimentary	Currently used, ecologically important, with low salinity (250-1,000 milligrams per liter [mg/L] mg/L chlorides [Cl^-])	Irreplaceable, high vulnerability to contamination
Land areas underlain by this aquifer: Red Hill Housing Community, Makalapa Crater					
30201121 (12212)	Pearl Harbor	Waimalu	Basal, confined, horizontally extensive lavas (flank)	Currently used, ecologically important, with low salinity	Irreplaceable, moderate vulnerability to contamination

Table 3-5: PHNC Summary of Aquifer Characteristics

Aquifer Code	Aquifer Sector	Aquifer System	Aquifer Type	Development Stage/Utility/Salinity	Uniqueness*/Vulnerability to Contamination
Land areas underlain by this aquifer: Red Hill Housing Community, Makalapa Crater					
30201111 (11111)	Pearl Harbor	Waimalu	Basal, unconfined, flank	Currently used for drinking water and is fresh	Irreplaceable with a high vulnerability to contamination
Land areas underlain by this aquifer: Red Hill Storage Area, Public Works Center Compound, Halawa Housing Community					
30202111 (11111)	Pearl Harbor	Waiawa	Basal, unconfined, flank	Currently used for drinking water and is fresh	Irreplaceable with a high vulnerability to contamination
Land areas underlain by this aquifer: Little Makalapa, Makalapa, Manana					
30202116 (12211)	Pearl Harbor	Waiawa	Basal, unconfined, sedimentary	Currently used, ecologically important, with low salinity	Irreplaceable, high vulnerability to contamination
Land areas underlain by this aquifer: Beckoning Point, Bishop Point, Ford Island, Fort Kamehameha WWTP, Ford Island Housing Community, Shipyard, Hale Moku Housing Community, Hospital Point, Marine Barracks, McGrew Point, Pearl City Peninsula					
30202121 (12212)	Pearl Harbor	Waiawa	Basal, confined, flank	Currently used, ecologically important, with low salinity	Irreplaceable, moderate vulnerability to contamination
Land areas underlain by this aquifer: Pearl City Peninsula, Beckoning Point, Bishop Point, Ford Island, Fort Kamehameha WWTP NISMO, Naval Station, Richardson Recreation Center, Shipyard, Ford Island, Hale Moku Housing Community, Hospital Point, Marine Barracks, McGrew Point, Pearl City Peninsula					
30203116 (12211)	Pearl Harbor	Waipahu	Basal, unconfined, sedimentary	Currently used, ecologically important, with low salinity	Irreplaceable, high vulnerability to contamination
Land areas underlain by this aquifer: Pearl City Peninsula, NISMO, Naval Station, Richardson Recreation Center					
30203121 (12212)	Pearl Harbor	Waipahu	Basal, confined, flank	Currently used, ecologically important, with low salinity	Irreplaceable, moderate vulnerability to contamination
Land areas underlain by this aquifer: Pearl City Peninsula					
30104116 (23321)	Honolulu	Moanalua	Basal, unconfined, sedimentary	Potential use, not considered suitable for drinking water or ecologically important, moderate salinity (1,000 to 5,000 mg/l Cl)	Replaceable with a high vulnerability to contamination
Land areas underlain by this aquifer: Ohana Nui, Hoku Lani					
30104121 (11113)	Honolulu	Moanalua	Basal, confined, flank	Currently used for drinking water and is fresh (less than 250 mg/l Cl^-)	Irreplaceable with a low vulnerability to contamination
Land areas underlain by this aquifer: Ohana Nui, Hoku Lani					
30104111 (11111)	Honolulu	Moanalua	Basal, unconfined, flank	Currently used for drinking water and is fresh (less than 250 mg/l Cl^-)	Irreplaceable with a high vulnerability to contamination
Land areas underlain by this aquifer: Red Hill Storage Area, Waiawa Watershed, FFD, MSC/NEX/Commissary, Navy-Marine Golf Course, Public Works Center Compound, and Salt Lake Storage Area, Catlin Park, Doris Miller, Halsey Terrace, Maloelap, Moanalua Terrace, Radford Terrace Housing Communities					

* the aquifer is unique and its ecological value cannot be replaced because of its use for drinking water or for its ecological function;
Source: Mink and Lau 1990

3.3 GENERAL BIOTIC ENVIRONMENT

Information on biological resources presented in this and subsequent sections are primarily derived from surveys of terrestrial plants, terrestrial animals, and marine ecosystems conducted

as part of this INRMP and the 2001 INRMP. The reports are listed below and contained in the appendices.

- Pearl Harbor Coastal Zone Botanical Survey (NAVFAC PAC 2006b) (Appendix A1)
- Red Hill Fuel Storage Area Fleet Industrial Supply Center Botanical Survey 2006 (NAVFAC PAC 2006i) (Appendix A2)
- Waiawa Watershed Botanical Survey (NAVFAC PAC 2006j) (Appendix A3)
- Botanical Survey of Mangrove Community in Pearl Harbor, Pearl Harbor, O'ahu (Char 2000c) (Appendix A4)
- Botanical Survey of Makalapa Crater Naval Station Pearl Harbor, O'ahu (Char 1999) (Appendix A5)
- Botanical Survey of Red Hill Fuel Storage Area Fleet Industrial Supply Center Pearl Harbor, O'ahu (Char 2000a) (Appendix A6)
- Botanical Survey of Waiawa Watershed Public Works Center Pearl Harbor, O'ahu (Char 2000b) (Appendix A7)
- List of Plants at NAVMAG PH Lualualei and West Loch Branches (DON 2001b, Appendix C4);
- O'ahu Bird Surveys (NAVFAC PAC 2006a) (Appendix A8)
- O'ahu Herpetological and Mammal Surveys (NAVFAC PAC 2006d) (Appendix A9)
- Waiawa Stream Aquatic Species Survey (NAVFAC PAC 2007c) (Appendix A10)
- Survey of Avifauna and Feral Mammals for the Integrated Natural Resources Management Plan for Naval Station (NAVSTA), Public Works Center (PWC), and Fleet Industrial Supply Center (FISC) Pearl Harbor (Bruner 2000) (Appendix A11)
- Survey of Avifauna and Feral Mammals for the Integrated Natural Resources Management Plan for Naval Station Pearl Harbor, Makalapa Crater, O'ahu (Bruner 1999) (Appendix A12)
- List of Animals at NAVMAG West Loch Branch (DON 2001b), (Appendix C8)
- Wetlands Survey of Pearl Harbor (NAVFAC PAC 2007d) (Appendix A13)
- Marine Characterization of Fish and Benthic Communities of Pearl Harbor and Pearl Harbor Entrance Channel Hawai'i (Smith *et al.* 2006) (Appendix B1)
- Marine and Fishery Resources Pearl Harbor Integrated Natural Resources (Dollar and Brock. 2000) (Appendix B2)
- Turtle Densities in Pearl Harbor (NAVFAC PAC 2011) (Appendix B4)

The discussion of the general biotic environment is divided into five subsections (3.3.1 through 3.3.5): (1) threatened and endangered species, candidate species, and species of concern; (2) wetlands; (3) ecosystems; (4) wildlife; and (5) vegetation.

3.3.1 Threatened and Endangered Species and Petitioned Species

This section provides a summary of the federally-listed ESA threatened and endangered species and petitioned species at PHNC. It is organized in two parts with animal species discussed in Section 3.3.1.1 and plant species discussed in Section 3.3.1.2. Table 3-6 provides a listing of these species.

Table 3-6: Federally-Listed ESA Species, SOH-Listed Species, and Petitioned Species at PHNC

Latin Binomial	Common Name	Regulatory Status
Anas wyvilliana	Hawaiian Duck	E
Gallinula chloropus sandviciensis	Hawaiian Common Moorhen	E
Fulica alai	Hawaiian Coot	E
Himantopus mexicanus knudseni	Hawaiian Stilt	E
Gygis alba	White Tern	E (SOH only)
Asio flammeus sandwichensis	Hawaiian Short-eared Owl	E (SOH only)
Monachus schauinslandi	Hawaiian Monk Seal	E (proposed CH)
Megaptera novaeangliae	Humpback Whale	E
Eretmochelys imbricata	Hawksbill Sea Turtle	E
Chelonia mydas	Green Sea Turtle	T
Cyphastrea agassizi	Agassiz's coral	Petitioned
Cyphastrea ocellina	Ocellated coral	Petitioned
Leptoseris incrustans	Porcelain coral	Petitioned
Montipora dilatata	Hawaiian reef coral	Petitioned
Montipora flabellata	Blue rice coral	Petitioned
Montipora patula	Spreading coral	Petitioned
Porites pukoensis	No common name	Petitioned
Psammocora stellata	No common name	Petitioned

E – endangered; T – threatened; SOH – State of Hawaii; CH- critical habitat

3.3.1.1 Animals

Within Pearl Harbor there are federally- and SOH-listed birds, sea turtles, and marine mammals. All federally-listed species are also SOH-listed species. Critical habitat has not been declared within PHNC for any of these species. In addition, the USFWS maintains the Waiawa and Honouliuli Units of PHNWR, both of which provide habitat for protected bird species.

1. Bird Species:

There are four federally-listed endangered bird species found at PHNC: (1) Hawaiian duck or koloa (*Anas wyvilliana*); (2) Hawaiian common moorhen or ʻalae ʻula (*Gallinula chloropus sandvicensis*); (3) Hawaiian coot or ʻalae keʻokeʻo (*Fulica alai*); and (4) Hawaiian black-necked stilt or aeʻo (*Himantopus mexicanus knudseni*). There are two SOH-listed endangered endemic birds: (1) the white (fairy) tern (*Gygis alba*) or manu-o-kū, a seabird ; and (2) the Hawaiian short-eared owl (*Asio flammeus sandwichensis*) or pueo, a raptor.

Hawaiian Duck: The Hawaiian duck (Photo 3-9) is a federally-listed endangered, endemic waterbird that historically was found along the shoreline, estuarine, and freshwater habitats of Pearl Harbor. They were generally observed in the Honouliuli and Waiawa Units of the PHNWR and at the mouth of streams that flow into the harbor (NAVFAC PAC 2006a). Biologists believe that the Hawaiian duck has largely been replaced with a hybrid between the Hawaiian duck and mallard. State waterbird bi-annual survey efforts indicate that the hybridized duck numbers do dominate the Island of O'ahu. However, as recently as 2005, a Hawaiian duck was documented on O'ahu, through genetic testing, as result of an airstrike incident with a commercial airliner at Honolulu International airport. Hawaiian ducks are present on O'ahu (USFWS 2009).

Photo 3-9: Hawaiian duck

The Hawaiian duck is generally mottled brown and has a green to blue speculum with white borders. They can begin breeding at one year old and nest year-round, but the main breeding season is between January and May. Two to 10 eggs are laid in a well concealed nest lined with down and feathers. The incubation period is 30 days. Because their nests are established on the ground, they are highly vulnerable to mongoose (*Herpestes auropunctatus*), pig (*Sus scrofa*), and dog (*Canis domesticus)* attacks. Bullfrogs and bass sometimes eat the chicks. The species is vulnerable due to hybridization (interbreeding with other duck species). Threats to the species also include: (1) loss of wetlands; (2) introduced predators (dogs, cats [*Felis silvestris*], rats [*Rattus spp.*], black-crowned night herons [*Nycticorax nycticorx*], cattle egrets [*Bulbulcus ibis*], barn owls [*Tyto alba*], and non-native fish); (3) modifications to wetland habitats for flood control or to provide for municipal water sources; (4) invasive species including mangrove (*Rhizophora mangle*), pickleweed (*Batis maritime*); and water hyacinth (*Eichornia crassipes*) which reduce open water, mudflats, and shallows; (5) avian diseases including botulism (*Clostridium botulinum*); and (6) environmental contaminants including oil and fuel spills. Population estimates indicate that there are about 530 individuals remaining with 30 on O'ahu and 500 on Kaua'i (DOFAW 2005).

Hawaiian common moorhen: Hawaiian common moorhens (Photo 3-10) are federally-listed endangered, endemic, small, black waterbirds that can be found along the shoreline, estuarine, and freshwater habitats of Pearl Harbor (NAVFAC PAC 2006a). They are known to frequent the Honouliuli and Waiawa Units of the PHNWR. Breeding occurs year round, but peaks from March through August. Nesting phenology is apparently tied to water levels and the presence of appropriately dense emergent vegetation. Platform nests are constructed in dense vegetation over water. The moorhen lay approximately five to six eggs in a nest; the eggs have an incubation period of 19-22 days. The species uses a variety of freshwater habitats. They are opportunistic feeders and their diet varies with habitat but may include algae, grass seeds, plant material, insects, and snails. Hawaiian common moorhens are very secretive and, thus, are hard to monitor. Similar to other Hawaiian native waterbirds,

Photo 3-10: Hawaiian common moorhen

the common moorhen is threatened by habitat loss, introduced predators, altered hydrology, non-native invasive plants, and avian diseases. Population estimates indicate there are up to 300 Common moorhen in existence (DOFAW 2005).

Photo 3-11: Hawaiian coot

Hawaiian coot: Hawaiian coot (Photo 3-11) are federally-listed endangered, endemic, plump, chicken-like birds that can be found along the shoreline, estuarine, and freshwater habitats of Pearl Harbor including the Waiawa Unit of PHNWR (NAVFAC PAC 2006a). The species is somewhat gregarious and uses freshwater and brackish wetlands, including agricultural (e.g., taro fields) wetlands and aquaculture ponds. They are generalists and feed on land, from the surface of the water or will dive; they will also graze on grass adjacent to wetlands. Food items include seeds, leaves, snails, crustaceans, insects, tadpoles, and small fish. Nesting habitats includes freshwater and brackish ponds, irrigation ditches, and taro fields. Floating nests are constructed of aquatic vegetation and found in open water or anchored to emergent vegetation. They normally breed from March to September, but may breed during all months of the year. The incubation period is approximately 25 days, with fledging time unknown. Similar to other Hawaiian native waterbirds, the Hawaiian coot is threatened by habitat loss, introduced predators, altered hydrology, non-native invasive plants, and avian diseases. Population estimates range from 2,000 to 4,000 individuals (DOFAW 2005).

Photo 3-12: Hawaiian black-necked stilt

Hawaiian black-necked stilt: Hawaiian black-necked stilts (Photo 3-12) (also known as Hawaiian stilts) are federally-listed endangered, endemic, slim, wading birds that can be found along the shoreline, estuarine, and freshwater habitats of Pearl Harbor. In Pearl Harbor, the primary stilt habitat includes the Honouliuli and Waiawa Units of the PHNWR, as well as other shallow mudflats along the intertidal areas of Pearl City Peninsula and NAVMAG PH West Loch Branch (NAVFAC PAC 2006a). They are black above and white below and have long, pink legs. The breeding season of the black-necked stilt normally runs from mid-February through late August, with peak nesting varying among years. They lay three to four eggs in a nest over a four to five day period, and have an incubation period of approximately 23 to 26 days. Threats to black-necked stilts include introduced predators and loss of wetland habitats. Long-term census data suggests that the populations statewide are stable or slightly increasing. Population estimates range from 1,300 to 2,680 individuals (DOFAW 2005).

Photo 3-13: White (fairy) tern

White (Fairy) Tern: White (fairy) tern (Photo 3-13) is a SOH-listed threatened and MBTA-protected bird species that was recorded at PHNWR (NAVFAC PAC 2006a). It is a small, entirely white tern. Individuals have dark eyes and a thick, sharply pointed black bill with an electric blue bae. In Hawai'i, their diet consists mostly of juvenile goatfish and flying fish. Breeding adults remain close to nest sites and forage in inshore areas such as shoals and banks, with occasional forays into offshore waters. They do not construct nests but instead lay a single egg in a suitable depression including tree branches, building, rock ledges, or on the ground. Pairs will replace an egg after initial nest failure and some successfully raise two or three broods per year. Both parents incubate eggs and brood and feed the chick. Fledglings are dependent on adults up to two months. On O'ahu, the number of pairs has increased from one to greater than 250 between 1961 and 2005 (DOFAW 2005).

Photo 3-14: Hawaiian short-eared owl

Hawaiian short-eared owl: The Hawaiian short-eared owl (Photo 3-14) is SOH-listed as an endangered species on O'ahu and was recorded at Waipi'o Peninsula and PHNWR (NAVFAC PAC 2006a). It is an endemic subspecies of one of the world's most widely distributed medium-sized owls. Pueo occur on all the Main Hawaiian Islands (MHI), but are most common on Kaua'i, Maui, and Hawai'i. Unlike most owls, pueo are active during the day and are commonly seen hovering or soaring over open areas. They primarily consume small mammals. Females build nests on the ground constructed of simple scraps in the ground lined with grasses and feather down. Little is known about the breeding biology of pueo, but nests have been found throughout the year. Chicks hatch asynchronously and are fed by female with food delivered by male. Young may fledge from nest on foot before they are able to fly and depend on their parents for approximately two months. Pueo were widespread at the end of the 19th century, but are thought to be declining. They are threatened by loss and degradation of habitat, predation by introduced mammals, and disease. Population is unknown as few of the owls were detected during previous forest bird surveys (DOFAW 2005).

2. Marine Mammals

There are two federally-listed marine mammals found in Hawaiian waters at PHNC: (1) the endangered Hawaiian monk seal or 'ilio-holo-i-ka-uaua *(Monachus schauinslandi*); and (2) the endangered humpback whale or koholā (*Megaptera novaeangliae*).

Hawaiian monk seal:

Photo 3-15: Hawaiian monk seal

Description. The federally-listed, endangered Hawaiian monk seal (*Monachus schauinslandi*) is a pinniped, of the family Phocidae. Adult monk seals measure about 7 to 8 ft (2.1 to 2.4 m) in length and weigh about 400 to 600 pounds (180 to 270 kilograms) with females often being larger than males (University of Hawai'i at Manoa 2009). Hawaiian monk seals can live up to 25 to 30 years (Marine Conservation Biology Institute 2009). Mature Hawaiian monk seals are a silver or slate gray on their dorsal side and have a cream coloring on their stomach, chest and throat. Between molts, their coats may fade to brown on their backs and to a yellowish tan on their fronts (Photo 3-15). Older seals may become a darker color as they age. All Hawaiian monk seals, except pups, undergo an annual catastrophic molt, shedding their coat and the outer layers of skin. Newborn pups of both sexes are black and weigh approximately 31 to 37.5 pounds (14-17 kilograms) (Kenyon and Rice 1959; Wirtz 1968). Some pups and adults have small white patches of pelage (NOAA Fisheries 2007). Pups shed their black coat at approximately six weeks. Following this first molt, the pups are silvery above with a creamy color below (NOAA Fisheries 2009c).

Status. Current population estimates of Hawaiian monk seals indicate approximately 1,200 seals remaining. This species is listed as endangered under the ESA and as a depleted and strategic stock under the MMPA (Ragen and Lavigne 1999; Caretta *et al*. 2005). The Hawaiian monk seal is the only endangered marine mammal whose entire range lies within the U.S. (however, the species has been sighted outside the U.S. Exclusive Economic Zone) (NOAA Fisheries 2007). Monk seals, including the Mediterranean monk seal (*Monachus monachus*), the Caribbean monk seal (*Monachus tropicalis*), and the Hawaiian monk seal, are the most primitive of the living phocid species, having anatomical features that resemble those of monk seal fossils from 14 to 16 million years ago.

Monk seals may have arrived in the Hawaiian Islands about 14 to 15 million years ago before the current MHI were formed, and eventually spread to the MHI over the past 6 million years (NOAA Fisheries 2009a). During the 19th and early 20th centuries, Hawaiian monk seal numbers were greatly diminished by seal hunters, sailors, and guano hunters. Activity and use of islands within the Northwest Hawaiian Islands (NWHI) varied during the early part of the 20th century. Examples include airport construction and use at Midway Atoll beginning in the 1930s, a pearl oyster fishery at Pearl Hermes Reef (PHR) from 1926-1930, and Navy training exercises at French Frigate Shoals (FFS) during the 1930s. This variability would have had a varying toll on the subpopulations of Hawaiian monk seals at these islands. Consistent declines in monk seal population trends have been recorded since range-wide surveys began in the 1950s. Between the late 1950s and 1980s, counts at the atolls, islands, and reefs in NWHI suggested a 50 percent decline in this population. In 1987, the total population for the five major breeding locations plus Necker Island was estimated at 1,718. In 1992, the estimate was 1,580 and 1,406 in 1993. In 2006, the Hawaiian monk seal population was estimated to be 1,200 animals (NOAA Fisheries 2009a) with only about 77 of them located in MHI in 2005 (NOAA Fisheries 2007).

In 1976, the U.S. government listed the Hawaiian monk seal as endangered under the ESA. In the same year, the MMPA designated the species as "depleted" (NOAA Fisheries 2007). Critical habitat for the Hawaiian monk seal was first designated in 1986 at all beach areas,

lagoon waters, and ocean waters out to a depth of 10 fathoms (60 ft or 18 m) around Kure Atoll, Midways Islands (except Sand Island), PHR, Lisianski Island, Laysan Island, Gardner Pinnacles, FFS, Necker Island, and Nihoa Island (April 30, 1986, 51 FR 16047). However, concerns raised by the Marine Mammal Commission, Hawaiian Monk Seal Recovery Team, and non-governmental organizations prompted NOAA Fisheries to reopen the comment period on the critical habitat Environmental Impact Statement, and in 1988 critical habitat was extended to include Maro Reef and waters around the previously identified areas out to the 20 fathom isobath (120 ft, 37 m) (53 FR 18988, May, 26, 1988; 50 CFR 226.201) (NOAA Fisheries 2007). NOAA Fisheries was petitioned to revise the habitat in July of 2008. Ninety days later, in accordance with the process, NOAA Fisheries found that the petition may be warranted. Upon review of the best available information regarding Hawaiian monk seal biology and habitat use, NOAA Fisheries announced its intention to revise critical habitat in June of 2009. The petition was predicated on the importance of terrestrial and marine habitat for monk seals around the entire Hawaiian Archipelago. The petitioners cited studies indicating that while a significant portion of the species' population is found throughout the NWHI (NOAA Fisheries 2007), it is likely that Hawaiian monk seals are recolonizing the MHI (Baker 2006) since the seals have been sighted on each of the eight MHI and their presence is increasing (NOAA Fisheries 2007). While NOAA Fisheries has not officially identified habitat that may be included in the revision, the petition seeks to include key beach areas, sand spits, and islets, including all beach crest vegetations to its deepest extent inland, lagoon waters, inner reef waters, and ocean waters out to a depth of 100 fathoms or 600 ft (183 m) around the MHI and to extend critical habitat designation in the NWHI out to a depth of 1,640 ft (500 m).

Range and Habitat. There is a tendency for Hawaiian monk seals to frequent remote areas where human presence or access is limited. Most Hawaiian monk seals live in the NWHI including the six main reproductive sites: Kure Atoll, Midway Islands, PHR, Lisianski Island, Laysan Island, and FFS. Smaller breeding subpopulations are also supported within the NWHI on Necker Island and Nihoa Island (NOAA Fisheries 2007). Hawaiian monk seals travel to Maro Reef and Gardner Pinnacles and have occasionally been sighted on nearby island groups such as Johnston Atoll, Wake Island, and Palmyra Atoll (Rice 1998). Within the past 15 years, sightings of Hawaiian monk seals on the MHI have increased considerably (Baker and Johanos 2004; Carretta *et al*. 2005; NOAA Fisheries 2009a, b). Seals have been reported on each of the MHI with at least 45 seals in 2000, 52 in 2001, 77 in 2005, and 83 in 2006. These numbers are considered to be well below true abundance since they are based on non-systematic sightings of tagged and naturally marked seals. It is possible that Hawaiian monk seals may be re-colonizing the MHI, which was likely part of their historic range (NOAA Fisheries 2007).

Haul-out areas for pupping, nursing, and resting are primarily sandy beaches, but virtually all substrates, including emergent reef and shipwrecks, are used at various islands. At PHNC, Hawaiian monk seals frequently haul-out primarily on a sandy beach at Iroquois Point-Pu'uloa Beach (versus emergent reef); however, one seal has been observed hauled out in the vicinity of Marine Railway No. 2 at the Shipyard (Figure 3-22). The coastline at PHNC is a mixture of exposed coralline algal reef, weathered limestone and sandstone (emergent coralline algal reef), medium to coarse sand, and developed areas such as piers, docks, and sheet pile.

Monk seals spend about two-thirds of their time in the water. They are primarily benthic foragers and will search for food in coral reef habitat and on substrate composed of talus and sand on marine terraces of atolls and banks to depths exceeding 1,604 ft (500 m). They have been observed feeding in reef caves that are also used for rest and for refuge from predators. Seals have also been observed breathing from air bubbles trapped on cave ceilings suggesting that this may be a means of extending a seal's underwater time (NOAA Fisheries 2007).

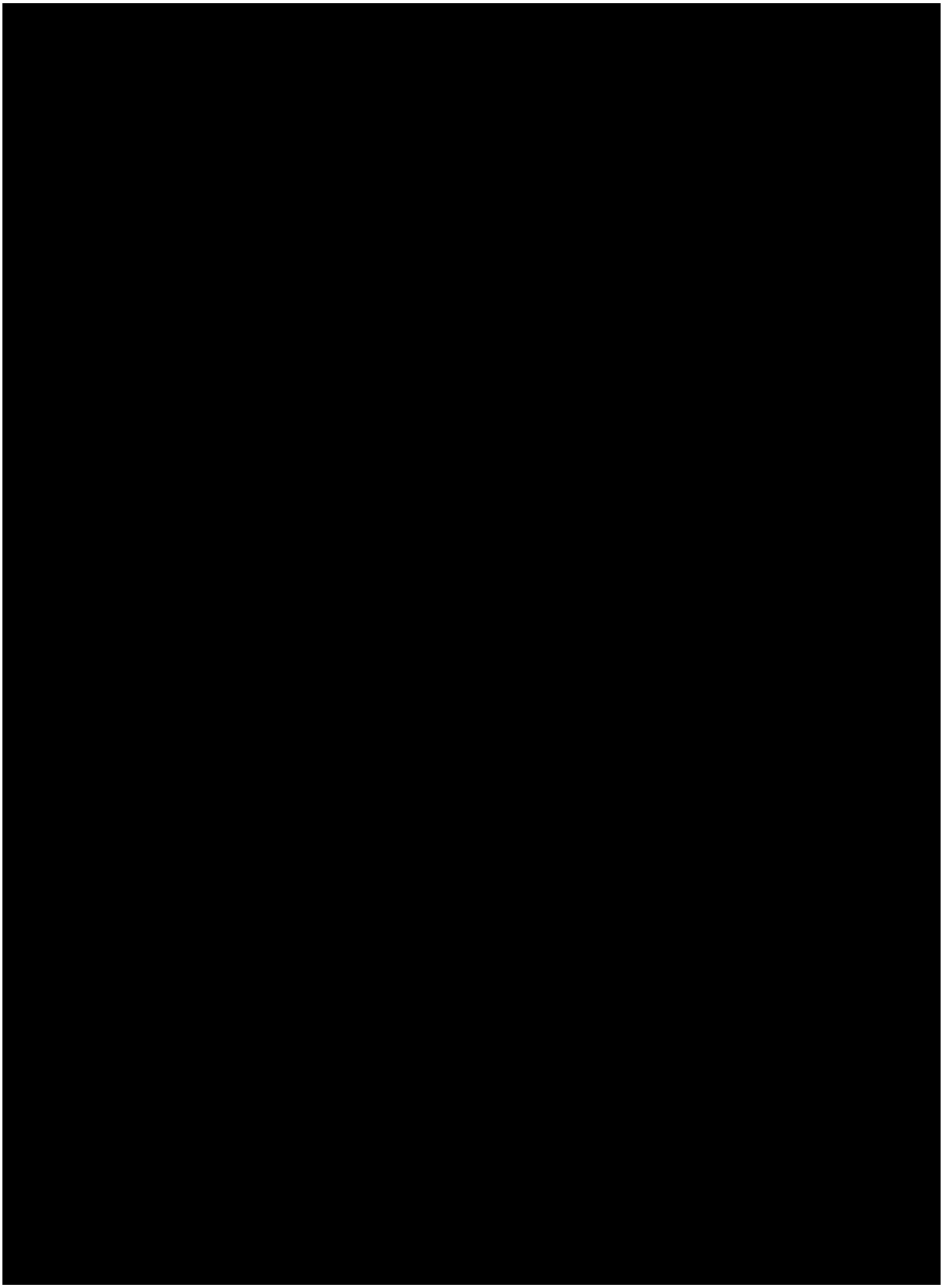

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Figure 3-22: Hawaiian Monk Seal Haul Out Areas at PHNC

Feeding. Monk seals feed on a wide variety of fishes, cephalopods, and crustaceans. They are considered foraging generalist that prey on benthic and demersal prey. Research suggests that the majority of their diet (~79%) is fish, followed by cephlapods (~16%) and crustaceans (~6%). Fish families reportedly common in their diet include Labridae, Holocentridae, Balistidae, and Scaridae. Cephalapod prey includes seven species of octopus and 19 species of squid. Recent information indicates that monk seals forage in beds of precious coral below 984 ft (300 m) in the subphotic zone (NOAA Fisheries 2007).

Reproduction. Females give birth for the first time between the ages of five and nine years of age. There is a decline in fecundity past an age of 10 to 15 years. Age of sexual maturity for males is unknown but is suggested to be approximately the same as females. Because mating occurs at sea and is seldom observed, little is known about reproductive success (NOAA Fisheries 2007).

Pregnant females select a site, usually the same each year, for parturition, and give birth to a single offspring. Pups usually nurse for 5-6 weeks and weigh about 110 to 220 pounds (50-100 kilograms) at weaning. Female monks seals usually fast and remain with their pups throughout the nursing period. Nursing monk seal mothers are generally intolerant of other adult seals, including other mothers with pups. However, they do not appear to distinguish consistently their own pups from others' pups and occasional switching of pups occurs on beaches with multiple mother and pup pairs. Switching or fostering of pups appears to have minimal effects on first year survival in cases where the pups are of comparable size (NOAA Fisheries 2009a).

Weaning occurs when the mother abandons her pup and returns to the sea to resume feeding. Over the next few months, she will regain a considerable amount of the mass lost during lactation. About three to four weeks after weaning her pup, she will mate and five to six weeks later, she will haul out again for 10-14 days or more to molt. On average, females that do not give birth in a given year will molt a month earlier (NOAA Fisheries 2007).

For the pup, weaning marks an abrupt and critical transition to independence. The months following weaning, the pup must learn to live and forage independently. In the process, the pup will lose a considerable amount of the mass gained during nursing. Until they begin to forage, two to four months after weaning, pups lose 0.33% of their weaning body mass per day (NOAA Fisheries 2007).

Annual Hawaiian monk seal births have increased since the mid-1990s with documented births on most of the major islands. Monk seal births have been documented in all months of the year but are most common between February and August, peaking in March and April (NOAA Fisheries 2007). In general, sandy beaches with shallow protected water near shore seem to be preferred habitat for pupping and nursing (NOAA Fisheries 2007). Pupping events have not been recorded at PHNC during the Navy's tenure.

Threats. The diminishing population of Hawaiian monk seals makes the species severely vulnerable to natural and anthropogenic factors that may affect their continued existence and recovery. The threats impacting Hawaiian monk seals have been assessed by the Hawaiian Monk Seal Recovery Team based on severity and magnitude, as well as the scope and geographic range. Table 3-7 provides a summary of these threats.

Table 3-7: Summary of Threats to Hawaiian Monk Seals

Threat Type	Description
Crucial: ongoing sources of mortality that are apparent at most sites in NWHI	
Food limitation	Food limitation regulates the population growth in NWHI and is evidenced by the decline in juvenile survival rate and significantly smaller pup and juvenile sizes. In contrast, pups in the MHI tend to wean much larger than in NWHI.
Marine debris entanglement	Hawaiian monk seals have one of the highest documented entanglements rates of any pinniped species, and marine debris and fishing gear are chronic forms of pollution affecting the NWHI. Despite dwindling numbers of Hawaiian monk seals, the number of monk seals found entangled has not changed and the accumulation rate of marine debris at NWHI has remained unchanged.
Shark predation	There has been a significant increase in shark predation on monk seal pups born at FFS, where shark related injury and mortality of pre-weaned pups have been conspicuously higher than other sites. Field observations indicate that shark predation may also be compromising recovery of Hawaiian monk seals at Midway and Kure Atoll.
Serious: ongoing impacts with potential for range-wide concern	
Disease	Mortality events in the NWHI have led to concern about the presence of diseases in monk seal populations. There is heightened concern about monk seal exposure to diseases that they have not previously encountered, such as leptospirosis, toxoplasmosis, and West Nile virus. The lack of antibodies in monk seals to these diseases makes them extremely vulnerable to potential infection. The frequency of the outbreaks is rare but the potential for devastating effects is of great concern should the diseases spread throughout the population.
Loss of terrestrial habitat	A significant issue of concern for Hawaiian monk seals in NWHI is the loss of terrestrial habitat as a result of environmental factors such as storms and sea level rise. Sea level rise over the longer term may threaten a large portion of the resting and pupping habitat at NWHI.
Fishery interaction	Species management actions by NOAA Fisheries have limited direct and indirect fisher interactions with Hawaiian monk seals in the NWHI; however, Hawaiian monk seals in the MHI have required interventions due to embedded hooks from recreational fishing and recent mortalities in gillnets.
Male aggression	The primary identified cause of adult and immature female mortality affecting the recovery potential in monk seal population in the 1980s and early 1990s, was injury and often death caused by multiple (Hawaiian monk seal) male aggression. Attacks by single adult males have also resulted in several monk seal mortalities at most or all locations. These behaviors range from normal pinniped male harassment of younger animals to an aberrant level of focused aggression, especially directed toward weaned pups
Human interaction	Hawaiian monk seals in the NWHI avoid beaches for breeding where people have often disturbed them, but sightings of monk seals in the MHI have increased, resulting in increased human interactions by beachgoers. These interactions increase the concern about harassment of seals. Recent successful monk seal pupping events on popular MHI beaches have occurred, despite the major management challenges to staff, volunteers, resources, public outreach, and collaboration. Disturbance of seals on MHI beaches may limit seals' ability to make use of habitats. If the MHI population grows, both in absolute number and proportion of total abundance, disturbance will become a larger management challenge.
Moderate: possible localized impacts but are not considered serious or immediate cause of concern.	
Biotoxins	In 1978, a significant number of Hawaiian monk seals died on Laysan Island, and high levels of ciguatoxin and maitoxin were detected in the livers of two seals. Remote sensing of monk seal habitat has indicated that the potential impact of dangerous algal blooms which could contain harmful species.

Table 3-7: Summary of Threats to Hawaiian Monk Seals (Continued)

Threat Type	Description
Vessel groundings	Hawaiian monk seals may potentially be injured or killed by vessel grounding that result in the release of hazardous materials, including oil or fuel spills, rotting bait, lost gear that creates entanglement hazards, and human disturbance resulting from a grounding incident. These events are typically episodic and affect a limited area when they occur. To date, no seal mortalities have been attributed to vessel groundings.
Contaminants	Hawaiian monk seals are exposed to organochlorines with concentrations of polychlorinated biphenyls found in biological samples. In the NWHI, contaminants originating from human occupation have been identified in Hawaiian monk seal habitat. The effects of these compounds on monk seal health, reproduction, and survival are unknown.

Source: NOAA Fisheries 2007 Recovery Plan for the Hawaiian Monk Seal

Humpback whale: During the winter breeding season from December through April, the federally-listed endangered humpback whale (Photo 3-16) is present in coastal waters, primarily within water depths of 985 ft (300 m) of the MHI. Whale sightings in the vicinity of Pearl Harbor are extremely rare. A humpback whale was sighted within Pearl Harbor/PHEC on 9 August 2005 and an adult humpback whale and calf were reported in East Loch on 21 March 1998 (Smith *et al.* 2006).

Photo 3-16: Humpback whales

3. Reptilian Species: There are two federally-protected marine reptiles (sea turtles) at PHNC. All sea turtles are protected under the federal ESA. The threatened green turtle or honu (*Chelonia mydas*) is actually quite common in the Hawaiian Islands and is observed at Pearl Harbor. The endangered hawksbill turtle or honu'ea (*Eretmochelys imbricata*) is considered rare compared to the threatened green turtle.

Photo 3-17: Green turtle

Green turtle: Green turtles (Photo 3-17) are the only protected marine species which are routinely encountered within PHEC. As adults, green turtles forage and rest in the shallow waters around the MHI. Reproduction in the Hawaiian population occurs primarily in the NWHI but PHEC supports a modest resident population of these sea turtles (Smith *et al.* 2006). The PHEC provides both preferred resting habitat and preferred forage habitat. The amount of preferred algal forage does not appear to have changed in the past several years; however, resting habitat has increased, if one includes the pile supported portions of the Fort Kamehameha Outfall Extension. Unlike PHEC, there are no significant quantities of preferred algal forage within Pearl Harbor and the preferred resting habitat is limited. With the possible exception of West Loch, few if any green turtles are resident within Pearl Harbor. Those individuals that are sighted are most likely transient (Smith *et al.* 2006).

Adults migrate to the isolated NWHI in the summer to nest and return to the MHI in late summer or early fall. Nesting occurs on sandy beaches above the high tide mark; upon hatching, juvenile green turtles enter the ocean where they presumably take up a pelagic existence until attaining a carapace length of about 12 in (30 cm]). At this size, young green turtles take up residence in nearshore waters around the MHI.

Hawksbill turtle: There have only been two documented sightings of hawksbill turtles (Photo 3-18) in Pearl Harbor or the PHEC. The first occurred on 14 March 2004 (Smith et al. 2006) near Bishop Point; the second sighting was on 23 October 2008 near Channel Marker Buoy No. 6 in the PHEC (Smith, personal communication). It should be noted, that sea turtle survey dives have been conducted in Pearl Harbor and the PHEC on a quarterly basis since 2000. It is clear, therefore, that hawksbills are very rare in this area.

Photo 3-18: Hawksbill turtle

Hawksbill turtles are most often found in shallow water around reefs, bays, and inlets. Nesting areas are extremely critical to the survival of the species, which prefers areas with woody cover for nesting. The main threats to the species are the reduction of nesting beaches due to construction and human presence including vehicles, artificial lighting, nest predation, and exotic vegetation. In addition, marine debris from active and ghost fishing lines and lay nets cause incidental take. Pollutants and boat collisions may also be a threat (DOFAW 2005).

4. Corals: Corals are discussed in detail in Section 3.3.4.5.

3.3.1.2 Plants

There are no federally- or SOH-listed plant species that occur naturally in the PHNC. The USFWS and DLNR are currently raising federal- and SOH-listed endangered plants (*Pritchardia remota, Sesbania tomentosa, Abutilon menziesii*) at PHNWR Honouliuli Unit. These plants are not further discussed in this INRMP.

3.3.2 Wetlands

The discussion of wetlands within PHNC includes: (1) a summary of the USACE-defined jurisdictional and reconnaissance level wetlands within the vicinity of Pearl Harbor; (2) a summary of the USFWS-defined wetlands within Pearl Harbor; (3) a description of wetlands within areas with significant natural resources; (4) wetlands within highly developed and/or industrialized areas; and (5) wetlands within Navy family housing communities.

3.3.2.1 USACE-defined Wetlands

As discussed in Section 1.5.5, USACE defines wetlands as having all three of the following characteristics: (1) vegetation that is at least periodically present and supports hydrophytes or water-loving plants; (2) soil substrate that is predominately undrained, hydric soil; and (3) water substrate that is non-soil and is saturated with water or covered by shallow water at some point during the growing season of each year. A USACE-defined jurisdictional wetland is subject to regulation under Section 404 of the CWA (Section 1.5.5).

USACE performed a wetland inventory of Pearl Harbor in 1999 (USACE 1999). NAVFAC PAC performed an update to the 1999 wetlands inventory in 2006 (NAVFAC PAC 2007d). As discussed in the wetlands inventory update, the responsibility for respecting and caring for aquatic habitats on Navy property is the main point of the wetlands surveys. In essence, nearly all natural aquatic environments in and around Pearl Harbor are encompassed by the CWA definitions as "special aquatic sites" and therefore are jurisdictional (NAVFAC PAC 2007d). There are six categories of aquatic sites: (1) sanctuaries and refuges; (2) wetlands; (3) mudflats; (4) vegetated shallows; (5) coral reefs; and (6) riffle and pool complexes in streams. All of these are subject to provisions of the CWA (NAVFAC PAC 2007d).

The 2006 wetlands surveys compares the wetlands conditions with those made by USACE in 1999 (Table 3-8). There are 126.9 ac (51.4 ha) of jurisdictional wetlands within Pearl Harbor with the majority (91%) colonized by mangroves, an invasive plant species (Table 3-9) Figure 3-23 shows the locations of the USACE certified jurisdictional wetlands and the reconnaissance wetlands identified in the 1999 USACE wetlands inventory of Pearl Harbor (USACE 1999).

Table 3-8: Summary of Changes in Pearl Harbor Wetlands (1999-2006)

Site	Description	Changes Since 1999	USACE 1999 Identification Number*
Puuloa Rifle Range and Iroquois Point Lagoon to Honouliuli Unit, PHNWR			
Golf course ponds	Eight ponds surveyed, none discussed	More ponds exist; no ponds surveyed in 2006	.1197-.1204
Puuloa Rifle Range	No wetlands	No changes	Not applicable
Iroquois Point Housing Lagoons	Man-made marine ponds with fill (rock or eroding shore)	Mangroves removed; minimal or no wetlands present	.2231-.2338
Loko 'Oki'okiolepe	Mangal within pond	Mangrove expanding	**.2206**
Loko Pamoku	Mangal within pond	Mangrove expanding	**.2207**
Unnamed mangal	Shoreline mangal	Mangrove expanding	**.2208 through .2212**
Unnamed pond	Mangal within pond	Mangrove expanding	**.2213**
Unnamed mangal	Shoreline mangal	Not seen in 1999	**.2214**
PHNWR Honouliuli Unit	Refuge wetlands	No change	**.33158, .3164, .3165**
West Loch Shoreline			
South end of ID .3163	Depression with a small palustrine wetland	Distinctive from ID .3163, a palustrine feature	**.3159**
Ponds surrounded by Batis flat		No change	**.3163**
Four ponds south of Honouliuli Stream mouth	Overgrown with mangrove	No change	**.3160 through .3162, .3178**
Mangrove at mouth of Honouliuli Stream and south along shore	A stream channel through mangal	No change	**.3166, .3177, and .3179**
Ka'auku'u Fishpond	Heavily overgrown with mangrove with some open water remaining (non-Navy land)	Less open water present	**.3181**
West Loch Shoreline Park	Mangrove, some areas of Batis (non-Navy land)	Some expansion of mangrove, but CCH removing mangrove along the park shore	none
Honouliuli Estuary	Channel lined with mangrove	No change	**.3175 through .3177**

Table 3-8: Summary of Changes in Pearl Harbor Wetlands (1999-2006) (Continued)

Site	Description	Changes Since 1999	USACE 1999 Identification Number*
Honouliuli Stream	Palustrine wetland overgrown with California grass	No change	**.3172, .3174, and .3177**
Golf course water supply reservoir and driving range	Wetland (non-Navy lands)	Not a wetland	.3182
West Loch Golf Course ponds and water traps	Wetlands (non-Navy lands)	Ponds, most do have non-jurisdictional wetland margins	.3168, .3169, .3171, .3173., .3183
Former Kahua Meat Company Pond	Pond utilized for treating wash-down effluent (non-Navy lands)	Filled in	.3167
Laulaunui Islet and fishpond	All low areas overgrown with mangrove	No change	**.3186 through .3196**
Private kalo lo'i	Spring-fed pond (non-Navy lands)	Stocked with ornamentals	**.3185**
West Loch north shore mangrove	Extensive mangal around old fishpond	No change	**.3219, .3220**
Pūpū'olē wetland	Depressional wetlands (non-Navy lands)	Nearly choked with California grass	**.3217, .3218**
West Loch north shore mangrove	Extensive mangal at mouth of Waikele Stream	Further expansion of mangrove in to West Loch; coalescence of numerous small clusters off stream mouth	**.3223 through .3230, .3239 through .3240**
Waipi'o Peninsula			
West Loch north shore mangrove	Pouhala Marsh (non-Navy lands)	On-going project to clean up marsh and playa areas and eliminate mangrove	**.4241**
West Loch north shore mangrove	Kapakahi Stream estuary (non Navy lands)	Mangroves removed	**.4243 through .4244**
West Loch northeast shore mangrove	Mostly a thin belt of mangrove off the old CCH ash landfill	No change	**.4245 through .4246, .4517 (or .4284)**
Former O'ahu Sugar Company settling ponds	Settling ponds that developed into extensive wetlands	Use curtailed prior to 1999 and now completely dried up.	None
Scattered shoreline areas west of Walker Bay	Small mangrove clusters	Unchanged	**.4062 through .4066**
Walker Bay, north shore	Mangal with batis flats behind	Unchanged	**.4068 through .4072**
Inland of north side of Walker Bay	Playas in man-made catchment basins	More than one feature is present	**.4067**
Walker Bay, south shore	Narrow band of mangrove at shore	Unchanged	**.4073 through .4076**
Wetland west of degaussing station	Interior wetland	Not investigated	**.4057**
West shore of Middle Loch	Narrow mangrove belt becoming mangal at north end	Unchanged	**.4052 through .4056, .4288**
Makalena Golf Course pond	Open water feature with margin of emergent vegetation (non-Navy lands)	Unchanged	**.4060**

Table 3-8: Summary of Changes in Pearl Harbor Wetlands (1999-2006) (Continued)

Site	Description	Changes Since 1999	USACE 1999 Identification Number*
Kahu Drainage Channel	Mangroves lining modified drainage channels (non-Navy lands)	Mangroves removed from smaller channels to maintain flood hydrology	**.4058 through .4059, .4061,** .4076 through .4078
Middle Loch and Pearl City Peninsula			
Kōlea Cove	Mitigation wetland (non Navy lands)	Much overgrown with loss of biological wetland functions	**.6285**
Middle Loch, northwest shore wetlands	Shoreline mangal (non Navy lands)	Significant portions of mangrove have been removed	.6077, .6079, **.6082** through **.6083**
Waiawa Springs	Numerous ponds/diked enclosures used for watercress production (non-Navy lands)	Many have been abandoned or are overgrown; .6125 reduced by fill	**.6104 through .6120, .6122 through .6125**
Bikeway drainage ditch	Depression overgrown with Batis (non-Navy lands)	Unchanged	**.6121**
Waiawa Unit, PHNWR	Man-made wildlife ponds	Unchanged; although fronting mangrove has been removed by USFWS	**.6080 through .6081**
Waiawa wetlands	Remnant low land areas on flood plain	More overgrown with elephant grass	**.6098 through .6101**
Former WWTP site	Batis wetlands and playa	Unchanged	**.6084 through .6086**
Waiawa Stream estuary	Mangal	Unchanged	**.6087 through .6088**
Drainage ditch	Narrow mangrove-lined channel	Unchanged	**.6093 through .6098, .6287**
Middle Loch east shore	Narrow shoreline mangrove lands	Unchanged	**.6090 through .6092**
Northwest shore of East Loch	Shoreline mangal (non-Navy lands)	Portions appear to have been filled	**.6102 through .6103 and .7270**
North Shore of East Loch: Waiau to Kalauao Stream			
Northwest shore of East Loch	Shoreline mangal (non-Navy lands)	Portion appears to have been filled since 1999	**.6103**
North shore of East Loch	Shoreline mangal (non-Navy lands)	Mangroves removed in front of HECO Waiau Plant	**.7270**
Abandoned pondfields	Four diked ponds presumably used for watercress or taro production (non Navy lands)	Abandoned before 1999	**.6251 through .6254**
Pondfields north of H-1	Spring-fed, diked ponds used for watercress or taro production (non Navy lands)	Still in use	**.6255**
Pondfields south of H-1	Spring-fed, diked ponds used for watercress or taro production (non Navy lands)	Most still in agricultural use	**.7256 through .7267**
Waiau cooling water pond	Spring-fed, diked ponds (non Navy lands)	Emergent vegetation lacking	.7268
East of Pearl City Stream	Palustrine wet area(s) (non Navy lands)	Only .7258 seen in 1999	**.7258, .7269**
Shoreline mangrove east from Waiau to Blaisdell Park	Isolated mangrove copses and mangal (non Navy lands)	Most or all of the mangrove has been removed	.7129-.7130, **.7131**, .7132-.7133, .7271-.7261

Table 3-8: Summary of Changes in Pearl Harbor Wetlands (1999-2006) (Continued)

Site	Description	Changes Since 1999	USACE 1999 Identification Number*
Waiau wetland north of Kamehameha Highway	Spring-fed wetland with pondfields (non Navy lands)	Small agricultural plots	**.7128**
Blaisdell Park	Mangrove and pickleweed flat (non Navy lands)	Mangrove growth consolidated into mangal	**.7140, .7144 .7145**
Kalauao Spring	Sumida Watercress Farm (non Navy lands)	Commercial use continues	**.7049**
Harbor Center	Drainage ditches (non Navy lands)	No change	**.7152, .7275**
Mangroves, Waimalu Stream to Kalauao Stream	Isolated mangrove copses and some mangal areas (non Navy lands)	Some consolidation, other growths are too small to regard as wetlands	**.7035-.7038**, .7040, **.7041, .7043**, .7047-.7048, .7053-.7056, .7057-9, **.7057-.7059,** .7283
Pearl Kai wetland	Mitigation pond (non Navy lands)	Generally overgrown	**.7042**
Eastern Shore: McGrew Point to Bishop Point and Ford Island			
Loko Pa'aiau	Former fishpond, overgrown with mangrove	No change	**.8001**
McGrew Point	Scattered mangrove growth along the shore	Potentially one area (.8007) consolidating towards mangal	**.8007** to .8022, .8045 to .8046
'Aiea Bay	Extensive mangal at head of embayment	All mangrove removed in 2007	.9024 to .9034
Halawa Stream	Mangals along the estuary	In part removed by bridge reconstruction	.10050 through .10051
Makalapa Crater	California grass and pickleweed patches; not wetlands	Not known, but unlikely changed into wetlands	.11200 and .11201**

Source: NAVFAC PAC 2007d; *Appendix A13, Figures 1-1 to 6-1; **Misnumbered by USACE (1999) on their index maps as .01200 & .01201; Note: ID numbers in **bold** are jurisdictional wetlands; others are not.

Table 3-9: Jurisdictional Wetlands of Pearl Harbor

Location	Mangrove ac (ha)	Other Coastal ac (ha)	Stream ac (ha)	Other Fresh Water ac (ha)	Total ac (ha)
Pearl City Peninsula	53.05 (21.47)	3.85 (1.56)	0.10 (0.04)	6.24 (2.53)	63.24 (25.60)
Waipi'o Peninsula	36.61 (14.82)	0.86 (0.35)	0.00 (0.00)	0.00 (0.00)	37.47 (15.21)
West Loch	14.74 (5.97)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	14.74 (5.97)
McGrew Point	5.27 (2.13)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	5.27 (2.13)
Iroquois Point Lagoon	2.86 (1.16)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	2.86 (1.16)
Naval Station	0.13 (0.05)	0.00 (0.00)	0.25 (0.10)	0.00 (0.00)	0.38 (0.15)
All other areas of Pearl Harbor	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Totals	112.66 (45.60)	4.71 (1.91)	0.35 (0.14)	6.24 (2.53)	123.96 (50.18)
Percentage	91.10%	3.71%	0.28%	4.92%	

Source: USACE 1999

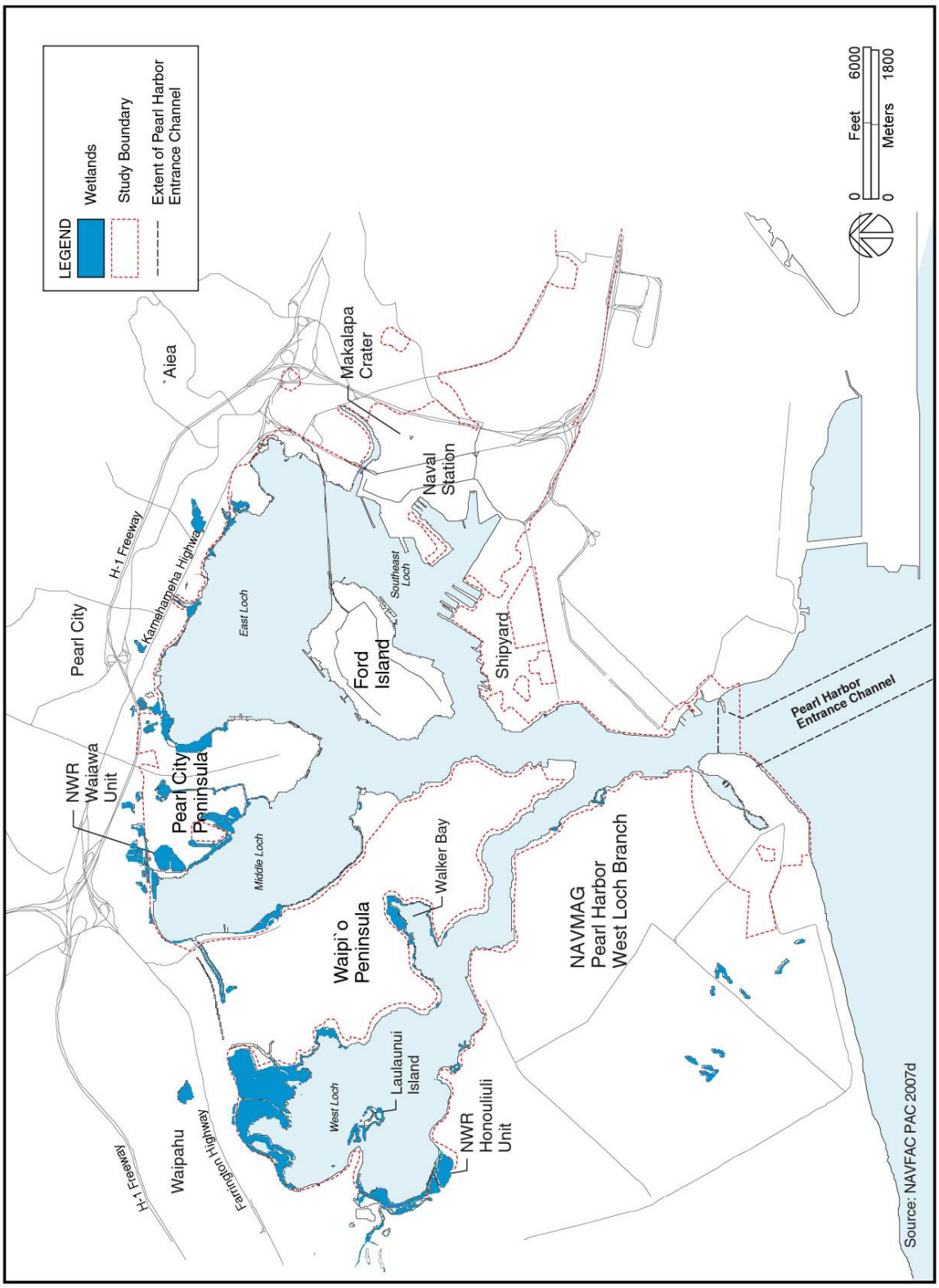


Figure 3-23: Wetlands of Pearl Harbor, O'ahu

3.3.2.2 USFWS-defined Wetlands

As mentioned in Section 1.5.5, the USFWS National Wetland Inventory (NWI) uses a much broader definition of wetlands than the CWA, requiring that only one or more of the wetland parameters (vegetation, soil, water) be present to be considered a wetland; however, from a natural resources management perspective, USFWS-defined wetlands are very important. Because of the more expansive definition of a wetland, NWI maps include areas that are not considered jurisdictional wetlands; non-jurisdictional wetlands are not subject to federal laws and regulations (Section 1.5.5) but can contain important habitat to resident species. The 1999 NWI for Pearl Harbor identified a total of 5,207.2 ac (2,107.4 ha) of wetlands within Pearl Harbor. These are summarized in Table 3-10.

Table 3-10: NWI Wetland Classification (1999)

Wetland Type	Area in ac (ha)
Estuarine Permanently Flooded (includes the waters of Pearl Harbor)	4,758 (1,926)
Intertidal (extending upstream and landward to where ocean-derived salts measure less than 0.5 per thousand during the period of average annual low flow)	368 (149)
Palustrine (non-tidal wetlands dominated by trees, shrubs, persistent emergent vegetation and all wetlands that occur in tidal areas with salinity below 0.5 per thousand)	73 (30)
Riverine (wetlands and deepwater habitats contained within a channel, which periodically or continuously contains moving water)	8 (3)
Total	5,207 (2,107)

3.3.2.3 Areas with Significant Natural Resources

1. Pearl Harbor

The wetlands of Pearl Harbor provide important wildlife habitat, are biologically rich and diverse areas, and are an important natural resource. Wetland areas adjacent to Pearl Harbor, which include mudflats, shallow ponds, small streams, mangal, pickleweed beds, cattails beds and watercress beds, provide a variety of habitat types for fishes, crustaceans, aquatic plants, and waterbirds, including the federally-listed endangered waterbirds. In addition, there are four historic fishponds (Loko Laulaunui, Loko Pa'aiau, Loko 'Oki'okiolepe, Loko Pamoku) that are part of the Pearl Harbor wetlands.

PHNWR: The PHNWR is managed by USFWS and consists of two units: (1) the Honouliuli Unit located along the west shore of West Loch and (2) the Waiawa Unit located near the east shore of Middle Loch (Figure 3-23). The PHNWR was created in 1976 to partially mitigate loss of natural habitat resulting from the construction of the Reef Runway at Honolulu International Airport. The PHNWR provides habitat for numerous bird species, including four endemic, federally-listed endangered waterbirds (Section 3.3.1.1). The primary mission of the PHNWR is the management of Hawai'i's four endangered waterbirds: (1) the Hawaiian coot; (2) Hawaiian common moorhen; (3) Hawaiian black-necked stilt; and (4) Hawaiian duck. Secondarily, and consistent with this management, benefits are also realized for a variety of migratory waterbirds (NAVFAC PAC 2006a).

Wetlands within the PHNWR are primarily managed by manipulating the water level and controlling vegetation. Water levels are varied to control or foster certain plant species throughout most of the year, particularly during waterbird nesting seasons. Water levels are maintained at a relatively high level through the fall and winter. This is to provide a relatively constant water level suitable for Hawaiian coot and common moorhen nesting. Nesting by

these species tends to subside around February and water levels are normally lowered to accommodate black-necked stilt nesting. Stilts nest on open flats rather than in open water. During the stilt nesting season (February through July or August), water levels are pulsed or fluctuated to maintain nesting, foraging, and chick rearing habitat for stilts. Water level management is also a means for producing a variety of invertebrates and plants utilized by Hawai'i's four endangered waterbirds for food, nesting, thermal cover, and protection from predators (NAVFAC PAC 2006a).

Upon completion of stilt nesting and fledging in August, one of the two water impoundments is de-watered and mechanical vegetation control is achieved using small tractors and mowers. By late September or early October, the goal is to have habitat work completed and to begin re-flooding the impoundment. The mechanical vegetation removal allows creation of vegetation interspersion, variety in vegetative structure, thinning of vegetation, and control of plants less desirable to waterbirds (NAVFAC PAC 2006a).

A predator control program (by USFWS) is in operation yearlong. Fencing, live traps, and diphacinone bait stations are used in the program. The targeted species are mongoose, rats, and other feral animals; all of which will kill birds and destroy eggs (NAVFAC PAC 2006a).

During the fall and winter, portions of the shallow water and mudflat areas are maintained for migratory waterbirds that come from various parts of the world to winter in Hawai'i. This habitat provides feeding, loafing, and protected habitat during their stay. These migrants generally return to their breeding grounds around April (NAVFAC PAC 2006a).

Honouliuli Unit: The Honouliuli Unit of PHNWR (Photo 3-19) is approximately 36.6 ac (14.8 ha) and consists of two water impoundments. One impoundment is 4.8 ac (1.9 ha) and the other is 13.8 ac (5.6 ha). The remainder of the unit is comprised of shoreline and upland habitat. The salinity of the water in the impoundment is typically 4 to 6 parts per thousand (ppt) (NAVFAC PAC 2006a).

Photo 3-19: PHNWR Honouliuli Unit

In the early 20th century, the west shore of West Loch (known as Honouliuli) included numerous fishponds and a 31-acre (12.5 ha) salt evaporation pond. The salt pond was set aside as a wildlife sanctuary by the Navy in 1971, and in 1972 was modified to be managed as part of the National Wildlife Refuge system under a use agreement between the Navy and the USFWS.

The Honouliuli Unit has two ponds with nesting islands and flats and is surrounded on all sides by a chain link fence. Water from this unit comes from a well. The Honouliuli Unit also hosts the Hawai'i Nature Center's third grade wetlands education program that teaches students all over O'ahu about the value of wetlands. Every year, thousands of third grade students learn about the recovery of Hawai'i's four endangered waterbirds and the value of this refuge to their recovery.

The USFWS would like to remove red mangrove from the shoreline at the Honouliuli Unit (USFWS 2006). The project is aimed at restoring the shoreline to a more natural condition and improving the suitability for fish and other native coastal species. The USFWS would like the Navy's support in the effort to restore the natural habitat, including the mangrove removal.

Photo 3-20: PHNWR Waiawa Unit

Waiawa Unit: The Waiawa Unit of the PHNWR (Photo 3-20) is approximately 24.5 ac (9.9 ha) and consists of two water impoundments. One impoundment is 6.8 ac (2.8 ha) and the other is 13.8 ac (5.6 ha). The remainder of the unit comprises both shoreline and upland habitat. The salinity in the impoundments is often near that of sea water (approximately 35 ppt) and can be allowed to become hypersaline (NAVFAC PAC 2006a).

Man-made nesting islands for stilts are located within the two ponds. Water is pumped into the unit from the nearby Waiawa Spring, immediately north of the unit, and empties into adjacent Pearl Harbor. Water levels can be regulated in either of the two ponds via a manually operated gate. The refuge is surrounded on four sides by an 8 ft (2.4 m) high chain link fence to discourage human and predator intrusion. A trapping program for mongoose and feral dogs and cats is an ongoing part of refuge management. Specific management programs at the refuge include the maintenance of manmade ponds and wetlands, predator control, and the reduction of human disturbances. The Waiawa Unit does not presently support public use activity, although a number of volunteer organizations and individuals offer assistance with water quality monitoring, vegetation control, bird identification, and other tasks.

A project to remove approximately 5 ac (2.0 ha) of dense, tangled red mangrove from the shoreline was completed by USFWS in 2006. The project was aimed at restoring the shoreline to a more natural condition and improving the suitability for fish and other native coastal species (NAVFAC PAC 2006a).

A new brackish (7 ppt salinity) water well provides water to the refuge impoundments. Water flow is controlled by a mechanical timer which allows water to flow into the impoundments to be set at a specific rate and flow time per day. Salinity in the impoundments is higher than at the Honouliuli Unit because of the encroachment of harbor water into the Waiawa Unit. However, the salinity of the water has been very successfully used as a vegetation management tool at this unit with the side effect of limiting plant diversity and structure (NAVFAC PAC 2006a).

2. Makalapa Crater

In the past, wetland areas have been defined in the interior of Makalapa Crater. Several wetland plants have been recorded in the vicinity of a former pond; however, the absence of soil and hydrology indicators prevents this area as being defined as a USACE-defined wetland (USACE 1999; NAVFAC 2007d).

3. Pearl City Peninsula

Pearl City Peninsula historically included at least four fishponds bordering the outlet of Waiawa Stream at the northwest edge of the peninsula (Figure 3-8). The site of the PHNWR Waiawa Unit was formerly a brackish pond and marsh. Waiawa Stream drainage provides habitat for stilt and other birds. The areas around the Waiawa Stream drainage and most of the western shoreline have since been colonized by mangrove forest and, thus, eliminated the natural habitat for native birds.

As shown on Figure 3-23, USACE has defined several wetland areas at Pearl City Peninsula including the Waiawa Unit of PHNWR (discussed under Pearl Harbor). In addition to the Waiawa Unit, USACE defined five other wetlands within Navy property at Pearl City Peninsula: (1) Freshwater Wetland; (2) Mangrove Forest; (3) Drainage Ditch; (4) Waiawa Stream; and (5) Pickleweed Field at the abandoned sewage treatment plant. Further information can be obtained from *Wetlands of Pearl Harbor, Pearl Harbor, O'ahu, Hawai'i* (USACE 1999 and NAVFAC PAC 2007d).

4. Red Hill Storage Area

There are no USACE-defined or USFWS-defined wetlands at Red Hill Storage Area. No streams cross the site and there are no other surface water resources at the site.

5. Waiawa Watershed

There are riparian wetlands along both the Waiawa and Waimano Streams that flow through the Waiawa Watershed. These are classified by the USFWS NWI as "palustrine, forested, broad-leafed evergreen, temporary," indicating that the streams are intermittent and receive surface flow only during brief periods during the year. Stream bank overflow occurs about six times a year, but flooding at the level of the terrace is rare. The stream course is deep and wide enough to contain flood flows.

6. West Loch/Waipi'o Peninsula

Intertidal mudflats and mangrove areas occur along the shoreline of NAVMAG PH West Loch Branch on both the Waipi'o Peninsula and West Loch side. These areas are considered wetlands and include 'Oki'okiolepe Fishpond, PHNWR Honouliuli Unit, Walker Bay, Laulaunui Island (extant fishpond), and Loko Pamoku. These wetlands are discussed under Pearl Harbor.

There were two interior wetlands (located away from the coastal areas) on Waipi'o Peninsula that have provided habitat for waterbirds. They include two former O'ahu Sugar Company irrigation ponds. Since the cessation of sugarcane cultivation on Waipi'o Peninsula in 1995, the ponds have essentially dried up and no longer provide habitat for waterbirds (NAVFAC PAC 2001b).

3.3.2.4 Highly Developed or Industrialized Areas

Only one inland wetland has been described for the highly developed and/or industrialized areas of PHNC. There is a small mangrove wetland located slightly inland of Middle Loch at Beckoning Point (Figure 3-23).

3.3.2.5 Family Housing Communities

Two Navy family housing communities contain USACE-defined wetlands (Figure 3-23): (1) McGrew Point; and (2) Pearl City Peninsula. There are no wetlands in the interior of McGrew Point; however, there is a significant wetland along the shoreline (Loko Pa'aiau [fishpond]) as well as some low lying areas along the coast that are considered smaller wetlands. These wetlands have been colonized by pickleweed and mangrove. The wetland areas at the Pearl City Peninsula family housing are discussed under the Waiawa Unit of PHNWR and Pearl City Peninsula. Further information can be obtained from *Wetlands of Pearl Harbor, Pearl Harbor, O'ahu, Hawai'i* (USACE 1999; NAVFAC PAC 2007d).

3.3.3 Ecosystems

The native terrestrial ecosystem of the shoreline portions of PHNC is described as lowland dry (less than 50 in [120 cm] of rainfall/year) shrubland and grassland (Juvik and Juvik 1998). Undisturbed or relatively undisturbed portions of Pearl City Peninsula, Waipi'o Peninsula, and West Loch are examples of this type of ecosystem. The inshore portions are described as lowland dry and mesic (moist – 50 to 100 in [120 to 250 cm] of rainfall/year) forest, woodland, and shrubland. Forests and woodlands are dominated by trees and a forest canopy is dense (60 to 100 percent cover), while a woodland canopy is more open (10 to 60 percent). Shrublands are distinguished by multi-branched shrubs over 3.3 ft (1 m) in height (Juvik and Juvik. 1998). Relatively undisturbed or undisturbed areas of Makalapa Crater, Red Hill Storage Area, and Waiawa Watershed are examples of this type of ecosystem.

3.3.4 Fish and Wildlife

The discussion of terrestrial animals within PHNC focuses on the bird, mammal, amphibian, and reptile species within the six areas with significant natural resources value: (1) Pearl Harbor; (2) Makalapa Crater; (3) Pearl City Peninsula; (4) Red Hill Fuel Storage Area; (5) Waiawa Watershed; and (6) West Loch/Waipi'o Peninsula. In addition, a terrestrial aquatic survey was conducted at a portion of Waiawa Stream located at Waiawa Watershed (NAVFAC PAC 2007c). Animal surveys have not been completed for the developed portions of PHNC, including the family housing communities as these areas are not expected to have significant feral terrestrial animal species.

3.3.4.1 Bird Species

Table 3-11 at the end of this subsection provides a summary of the migratory birds observed at PHNC, Appendix A8 presents the result of the bird survey for JBPHH (NAVFAC PAC 2006a), Appendix A14 presents a listing of the bird species observed at PHNC based on previous PHNC bird surveys (Bruner 1999, 2000; NAVFAC PAC 2006a).

1. Pearl Harbor Shoreline

A bird survey was completed for the shoreline around Pearl Harbor in 1998 and 1999 (Bruner 2000). The survey was conducted from a boat and by walking accessible sites within the wetland habitat. Streams and fishponds were also investigated using a boat. The focus of the shoreline survey was to examine habitats suitable for foraging waterbirds and shorebirds.

A total of eight sites were examined as actual or potential habitats for waterbirds. The habitats at these sites included rocky shorelines with mangrove thickets, stream drainages with a mixture of introduced trees and grass, and remnant fishponds lined with mangrove and rocky shorelines. The majority of the shoreline is either too thick with non-native vegetation (e.g., mangrove) or the slope too steep to provide shallow areas suitable for wading birds like stilts.

Only three of the eight sites examined contained waterbirds at the time of the survey: (1) Waiawa Stream (Pearl City Peninsula); (2) Walker Bay (Waipi'o Peninsula); and (3) PHNWR. Waiawa Stream had four Hawaiian ducks and one black-crowned night heron. Walker Bay contained two black-necked stilts. A total of 15 black-necked stilts and 12 Hawaiian coots were observed at the PHNWR (Bruner 2000).

The primary reason for the scarcity of waterbirds and shorebirds along the Pearl Harbor shoreline is the limited number of areas with suitable foraging habitat for these species. Large sections of the shoreline are covered in a dense tangle of mangrove trees which restricts shallow water access to wading birds including the federally-listed endangered waterbirds, other native birds, and MBTA-protected migratory shorebirds. Other sections of the shoreline not covered with mangrove are steep and the water is too deep for wading birds or migratory shorebirds. The few areas where federally-listed endangered waterbirds were observed were the PHNWR Waiawa and Honouliuli Units and the mouths of streams.

PHNWR: The PHNWR provides habitat for numerous bird species (Appendix A14), including four endemic, federally-listed endangered waterbirds (Section 3.3.1.1).

Honouliuli Unit: The two most numerous endangered waterbirds using the Honouliuli unit are the Hawaiian coot and the black-necked stilt. Common moorhen and Hawaiian duck occur here but in lower numbers. All four species successfully breed and rear young here. In recent years, between 50 to 70 black-necked stilts have been fledged from the site annually. Hawaiian coot production has remained around 100 to 150 young per year. Hawaiian ducks are difficult to separate from Hawaiian duck-mallard hybrids; therefore, no accurate production data is available. Due to the low numbers of common moorhen occupying the refuge, production ranges from just two to four per year.

Waiawa Unit: The two most numerous endangered waterbirds using the refuge are the black-necked stilt and the Hawaiian coot, with the stilt being the most numerous. Common moorhen and Hawaiian duck occur, but in lower numbers. Successful breeding and rearing of young occurs here. Water salinity plays an important role in species numbers and diversity on this unit.

In recent years, between 10 and 27 Hawaiian stilt have been fledged from the site annually. The number of Hawaiian coot is lower than the Honouliuli unit with about 6 to 10 produced per year. As with the Honouliuli Unit, there are difficulties in distinguishing Hawaiian ducks from the Hawaiian duck-mallard hybrid, so no accurate production data is available. Common moorhen production ranges from about four to 10 per year due to the low numbers of this species occupying the refuge.

2. Makalapa Crater

A bird and mammal survey was conducted at Makalapa Crater in 1998 (Bruner 1999) and an update to the bird survey was conducted in 2006 (NAVFAC PAC 2006a). A total of 13 bird species were observed in 1998 and 16 bird species were observed during the 2006 bird survey update (Appendix A14).

MBTA-protected Pacific golden plovers (*Pluvialis fulva*), the most abundant migratory shorebird in Hawai'i, were observed at Makalapa Crater in 1998 and 2006. Cattle egret (*Bubulcus ibis*), an MBTA-listed bird species, were observed in 2006 (NAVFAC PAC 2006a); however, it should be noted that cattle egrets are an introduced species in Hawai'i and are considered a pest in Hawai'i. No seabirds were recorded at Makalapa Crater, which is not unexpected. No waterbirds were observed at Makalapa Crater, which is also expected due to the lack of suitable wetland habitat. No native landbirds were recorded during the survey which is not unexpected given the location, elevation, and types of habitats available. The short-eared owl forages in agricultural fields and pastures as well as lowland and upland forest habitat; however, none were recorded at Makalapa Crater although the species could forage in the area (Bruner 1999).

The majority of the bird species identified during both surveys are introduced species (Appendix A14).

3. Pearl City Peninsula: Within Pearl City Peninsula, the most valuable waterbird habitat (including habitat for federally-listed endangered waterbirds) can be found at the Waiawa Unit of PHNWR which is discussed in Section 3.3.2.3. Lawns and other open areas also provide habitats for MBTA-protected migratory birds (Pacific golden-plover and ruddy turnstone). A total of 26 bird species were recorded as part of the 1999 bird survey (Bruner 2000) and 14 species were observed during the 2006 bird survey update (NAVFAC PAC 2006a) at Pearl City Peninsula (Appendix A14). The federally-listed endangered, endemic waterbird, the Hawaiian black-necked stilt was observed during both surveys. Two MBTA-protected migratory birds, the Pacific golden-plover and the ruddy turnstone, were observed in the 1999 survey only (Bruner 2000). Cattle egret, a MBTA-listed bird, was observed during both surveys. One native shorebird and an MBTA-listed bird, the Hawaiian black-crowned night heron, was also observed during both surveys (Bruner 2000; NAVFAC 2006a). The majority of the birds surveyed in 1999 and 2006 are introduced bird species (Appendix A14).

4. Red Hill Fuel Storage Area: At Red Hill Fuel Storage Area, a total of 18 bird species were recorded as part of the 1999 and 2000 bird surveys (Bruner 2000) and 10 bird species during the 2006 bird survey update (NAVFAC 2006a) (Appendix A14). It should be noted that the 2006 bird survey update was conducted on a day with relatively high winds; therefore, there is a high probability that all species using the habitat on the ridge top were not recorded (NAVFAC PAC 2006a). One MBTA-protected migratory bird, the Pacific golden-plover, was observed during the 1999 and 2000 surveys (Bruner 2000). The majority of the birds surveyed in 1999-2000 and 2006 are introduced bird species (Appendix A14).

5. Waiawa Watershed: One native MBTA-protected bird, the black-crowned night heron, was observed during the 1999 and 2006 bird surveys (Bruner 2000; NAVFAC PAC 2006a). Three MBTA-protected migratory birds, the Pacific golden-plover, the wandering tattler, and the cattle egret, were observed during the 1999 bird survey (Bruner 2000). The streams within the Waiawa Watershed provide foraging habitat for the native, MBTA-listed, black-crowned night herons. The forested habitat along the streams and the upslopes of the valley host a wide variety of introduced birds. Despite its close proximity to the urbanized Pearl City Industrial Park and the Pacific Palisades housing development, the site provides a small oasis for birds. A total of 20 bird species were recorded as part of the 1999 bird survey at Waiawa Watershed (Bruner 2000) and 17 species of bird during the 2006 bird survey update (NAVFAC PAC 2006a) (Appendix 14).

6. NAVMAG PH West Loch Branch/Waipi'o Peninsula. A total of 18 bird species were recorded on the West Loch portion of the installation during the 2006 bird survey conducted by NAVFAC PAC (Appendix A14). The federally-listed endangered Hawaiian stilt and four MBTA-listed bird species (black-crowned night heron, cattle egret, Pacific golden plover, and ruddy turnstone) were recorded at West Loch. The remaining 13 bird species are introduced. The most abundant species recorded were spotted doves (*Streptopelia chinensis*) (introduced species), gray francolins (*Francolinus pondicerianus*) (introduced species), Pacific golden plovers (a migratory bird), and zebra doves (Geopelia striata) (introduced species) (NAVFAC PAC 2006a).

A total of 18 bird species were recorded at Waipi'o Peninsula during the 2006 bird survey conducted by NAVFAC PAC (Appendix A14). The SOH-listed endangered (on O'ahu) Hawaiian short-eared owl and four MBTA-listed bird species (black-crowned night heron, cattle egret, Pacific golden plover, and osprey) have been recorded at Waipi'o Peninsula. The most

abundant species observed are introduced species; they include common waxbills (*Estrilda astrild*), spotted doves, and Japanese white-eyes (*Zosterops japonicas*) (NAVFAC PAC 2006a).

Table 3-11: Summary of Migratory Birds Observed at PHNC

Hawaiian Name	Photograph/Common Name	Latin binomial	Comments
Not available	 Photo 3-21: California gull	*Larus californicus*	California gulls (Photo 3-21) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). California gulls forage in flight or pick up objects while swimming, walking, or wading. They mainly eat insects, fish, and eggs.
Not available	 Photo 3-22: Ring-billed gull	*Larus delawarensis*	Ring-billed gulls (Photo 3-22) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Ring-billed gulls forage in flight or pick up objects while swimming, walking, or wading. They also steal food from other birds and frequently scavenge. They are omnivorous and will eat insects, fish, grain, eggs, earthworms, and rodents.
Not available	 Photo 3-23: Laughing gull	*Larus atricilla*	Laughing gulls (Photo 3-23) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Laughing gulls are smallish gulls with a black heads. They take advantage of human habitat modifications by foraging in parking lots and dumps (Cornell Lab of Ornithology 2008).
Not available	 Photo 3-24: Bonaparte's gull	*Larus philadelphia*	Bonaparte's gulls (Photo 3-24) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Bonaparte's gull are small, graceful gulls with bright white patches in their wings. They winter near people, but breed in the summer in isolated taiga and boreal forest (subarctic) (Cornell Lab of Ornithology 2008).
Not available	 Photo 3-25: Franklin's gull	*Larus pipixcan*	Franklin's gulls (Photo 3-25) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Franklin's gulls are small, black-headed gulls of the prairies. They are common in the interior of North America and winter primarily along the Pacific Coast of South America with small numbers wintering in southern California and Central America (Cornell Lab of Ornithology 2008).

Table 3-11: Summary of Migratory Birds Observed at PHNC (Continued)

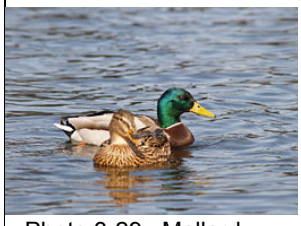
Hawaiian Name	Photograph/Common Name	Latin binomial	Comments
Not available	 Photo 3-26: Caspian tern	*Sterna caspia*	Caspian terns (Photo 3-26) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Caspian terns are the largest terns in the world. They are easily identified by their large coral red bills. They breed across North America and winter along the Pacific Coast from southern California to Guatemala as well as along the Atlantic coast, Gulf Coast, in the West Indies, Panama, northern South America, Africa, Mediterranean, and Indian Ocean (Cornell Lab of Ornithology 2008).
Not available	 Photo 3-27: Least tern	*Sterna antillarum*	Least terns (Photo 3-27) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Least terns are a small species of tern that breed in North America and locally in northern South America. They are migratory, wintering in Central America, the Caribbean, and northern South America (Cornell Lab of Ornithology 2008).
'Iwa	 Photo 3-28: Great frigatebird	*Fregata minor*	Great frigatebirds (Photo 3-28) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Great frigatebirds are large, graceful, indigenous seabirds that breed throughout the NWHI. They breed and roost on small remote islands, building nests on top of various species of bushes and trees. Introduced species (rats), habitat degradation, and over-fishing are threats to the species (DOFAW 2005).
Not available	 Photo 3-29: Mallard	*Anas platyrhynchos*	Mallards (Photo 3-29) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Mallards are one of the most familiar ducks and can be found throughout North America and Eurasia. They are found in all kinds of wetlands (Cornell Lab of Ornithology 2008).

Table 3-11: Summary of Migratory Birds Observed at PHNC (Continued)

Hawaiian Name	Photograph/Common Name	Latin binomial	Comments
Not available	 Photo 3-30: Eurasian wigeon	*Anas penelope*	Eurasian wigeons (Photo 3-30) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Eurasian wigeons are common in Europe and are sporadic visitors to North America. Regular in very small numbers along the Pacific and Atlantic coasts, singe individuals have been sighted in nearly every state.
Not available	 Photo 3-31: American wigeon	*Anas americana*	American wigeons (Photo 3-31) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). American wigeons are dabbling ducks that are considered widespread in North America and indigenous in Hawai'i. Primary threats to this species include loss of wetland habitat, degradation of habitat due to pollution, hydrology alternation, invasions by alien species, and avian diseases (DOFAW 2005).
Not available	 Photo 3-32: American green-winged teal	*Anas crecca (carolinensis)*	American green-winged teals (Photo 3-32) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). American green-winged teals are common and widespread ducks that breed in the northern areas of North America. They are the smallest North American dabbling ducks and can commonly be found in sheltered wetlands.
Not available	 Photo 3-33: Green-winged teal	*Anas crecca*	Green-winged teals (Photo 3-33) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Green-winged teals are very small, brightly patterned ducks that prefer shallow ponds with lots of emergent vegetation along the coast. They prefer tidal creeks, mudflats, and marshes to open water (Cornell Lab of Ornithology 2008).
Not available	 Photo 3-34: Garganey	*Anas querquedula*	Garganeys (Photo 3-34) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Garganeys are small dabbling ducks that breed in much of Europe and western Asia.

Table 3-11: Summary of Migratory Birds Observed at PHNC (Continued)

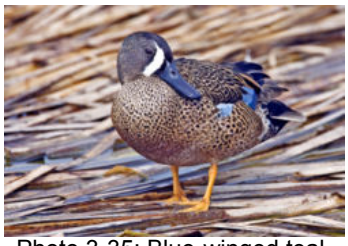
Hawaiian Name	Photograph/Common Name	Latin binomial	Comments
Not available	 Photo 3-35: Blue-winged teal	*Anas discors*	Blue-winged teals (Photo 3-35) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Blue-winged teals are small ducks of shallow ponds and seasonal and permanent wetlands. They breed across much of central and northern U.S. and Canada (Cornell Lab of Ornithology 2008).
Not available	 Photo 3-36: Cinnamon teal	*Anas cyanoptera*	Cinnamon teals (Photo 3-36) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Cinnamon teals are small, brightly colored ducks that are found in ponds throughout the American West. They use fresh water seasonal and semi-permanent wetlands of various sizes, including large marshes. These birds eat seeds, aquatic vegetation, aquatic and semi-terrestrial insects, snails, and zooplankton (Cornell Lab of Ornithology 2008).
koloa mohā	 Photo 3-37: Northern shoveler	*Anas clypeata*	Northern shovelers (Photo 3-37) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). The northern shoveler is a common North American dabbling duck that is indigenous to Hawai'i and winters in the MHI. These ducks typically arrive in Hawai'i in September and October and depart for Alaska by March or April. They utilize a variety of wetland habitats, including freshwater and saline marshes, and agricultural ponds. Primary threats include loss of wetland habitat due to pollution, development, or habitat-modifying invasive species and avian disease (DOFAW 2005).

Table 3-11: Summary of Migratory Birds Observed at PHNC (Continued)

Hawaiian Name	Photograph/Common Name	Latin binomial	Comments
koloa māpu	 Photo 3-38: Northern pintail	*Anas acuta*	Northern pintails (Photo 3-38) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Northern pintails are dabbling ducks that are common throughout the northern hemisphere; they are recognized as indigenous to Hawai'i. During the winter, the birds use a variety of shallow inland freshwater and intertidal habitats, typically shallow wetlands with little emergent cover. Threats to the species include avian disease and loss of wetland habitat due to development, habitat-modifying invasive plants, and pollution (DOFAW 2005).
Not available	 Photo 3-39: Lesser scaup	*Aythya affinis*	Lesser scaups (Photo 3-39) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Lesser scaups are medium-sized black-and-white, indigenous diving ducks. They are a regular but uncommon visitor to Hawai'i. They winter in fresh or brackish water and eat clams, snails, crustaceans, aquatic insects, and aquatic plants (Cornell Lab of Ornithology 2008). Threats to the species include avian disease and loss of wetland habitat due to development, habitat-modifying invasive plants, and pollution (DOFAW 2005).
Not available	 Photo 3-40: Ring-necked duck	*Aythya collaris*	Ring-necked ducks (Photo 3-40) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Ring-necked ducks are the most common diving ducks to be found on small ponds. They breed across Canada southward to the northern U.S. They winter across the southern U.S., up the coasts, and southward through Mexico, Central America, and the Caribbean (Cornell Lab of Ornithology 2008).
Not available	 Photo 3-41: Bufflehead	*Bucephala albeola*	Buffleheads (Photo 3-41) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Buffleheads are the smallest, North American diving ducks; they breed in Canada and winter in much of the U.S. They winter in shallow saltwater or in lakes or rivers (Cornell Lab of Ornithology 2008).

Table 3-11: Summary of Migratory Birds Observed at PHNC (Continued)

Hawaiian Name	Photograph/Common Name	Latin binomial	Comments
Not available	 Photo 3-42: Greater white-fronted goose	*Anser albifrons*	Greater white-fronted geese (Photo 3-42) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). In North America, greater white-fronted geese breed only west of the Mississippi; however, they have one of the largest ranges of any species of goose in the world, breeding across the tundra, Siberia, Russia, and in Greenland. They are found in flocks in wetlands and croplands (Cornell Lab of Ornithology 2008).
Not available	 Photo 3-43: White-faced ibis	*Plegadis chihi*	White-faced ibis (Photo 3-43) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). White-faced ibis are wading birds that breed colonially in marsh land from the western U.S., south through Mexico as well as southeastern Brazil, Bolivia, central Argentina, and along the coast of Chile. Their winter range extends from southern California and Louisiana south to include their breeding range.
Not available	 Photo 3-44: Cattle egret	*Bubulcus ibis*	Cattle egrets (Photo 3-44) were observed at Makalapa Crater, Pearl City Peninsula, Waiawa Watershed, NAVMAG West Loch, Waipi'o Peninsula/Laulaunui Island, and PHNWR. Cattle egrets are non-native shorebirds which were introduced to Hawai'i in 1959 from Florida to control insects that pestered cattle. They are common in many habitats around O'ahu (NAVFAC PAC 2006a). Cattle egrets are small white herons of pastures and roadsides. They are opportunistic feeders that eat insects as well as other birds (Cornell Lab of Ornithology 2008).

Table 3-11: Summary of Migratory Birds Observed at PHNC (Continued)

Hawaiian Name	Photograph/Common Name	Latin binomial	Comments
'Auku'u	 Photo 3-45: Black-crowned night heron	*Nycticorax nycticorax*	Black-crowned night herons (Photo 3-45) were observed at Pearl City Peninsula, NAVMAG PH West Loch, Waipi'o Peninsula, and PHNWR in 2006 (NAVFAC PAC 2006a). Black-crowned herons are indigenous to Hawai'i and are a medium-sized heron (waterbird). They are opportunistic feeders, eating items ranging from aquatic and terrestrial insects to lizards, snakes, eggs, and plant materials. Breeding occurs in Hawai'i from May to June. Similar to the other Hawaiian native waterbirds, this bird is threatened by loss and/or degradation of coastal plain wetland habitat; introduced predators (dogs, rats, cats, mongoose); non-native invasive plants (mangrove, pickleweed, water hyacinth) which reduce open water, mudflats, and shallows; avian diseases; and environmental contaminants (DOFAW 2005).
Not available	 Photo 3-46: Wilson's phalarope	*Phalaropus tricolor*	Wilson's phalaropes (Photo 3-46) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Wilson's phalaropes are the largest of the phalaropes. These birds are waders, and breed in the prairies of North America (western Canada and western U.S.). They are migratory, wintering in South America.
Not available	 Photo 3-47: Common snipe	*Gallinago gallinago*	Common snipes (Photo 3-47) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Common snipes are primarily birds of open freshwater marshes, bogs, wet meadows, and the northern tundra. They winter throughout the western and southern U.S. and can migrate as far as the Lesser Antilles and South America (Cornell Laboratory of Ornithology 2007).

Table 3-11: Summary of Migratory Birds Observed at PHNC (Continued)

Hawaiian Name	Photograph/Common Name	Latin binomial	Comments
Not available	 Photo 3-48: Long-billed dowitcher	*Limnodromus scolopaceus*	Long-billed dowitchers (Photo 3-48) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Long-billed dowitchers are long-billed shorebirds that are most common west of the Mississippi. They winter locally along both coast of the U.S. from California and North Carolina southward to northern Central America (Cornell Lab of Ornithology 2008).
Not available	 Photo 3-49: Stilt sandpiper	*Calidris himantopus*	Stilt sandpipers (Photo 3-49) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Stilt sandpipers are small shorebirds that breed in the open arctic tundra of North America and are a very long-distant migrant. They winter in mudflats, flooded fields, shallow ponds and pools, and marshes in the interior of South America as well as the very southern U.S. southward to Central America and northern South America (Cornell Lab of Ornithology 2008).
Not available	 Photo 3-50: Red knot	*Calidris canutus*	Red knots (Photo 3-50) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Red knots are medium-sized shorebirds that have one of the longest yearly migrations of any bird, traveling 9,500 mi (15,000 km) from their Arctic breeding ground to Tierra del Fuego in southern South America (Cornell Lab of Ornithology 2008).
Not available	 Photo 3-51: Sharp-tailed sandpiper	*Calidris acuminata*	Sharp-tailed sandpipers (Photo 3-51) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Sharp-tailed sandpipers are small waders that breed in the boggy tundra of northeast Asia. They are strongly migratory, wintering in southeast Asia and Australasia. These birds forage in on grasslands and mudflats. They mainly eat insects and other invertebrates.

Table 3-11: Summary of Migratory Birds Observed at PHNC (Continued)

Hawaiian Name	Photograph/Common Name	Latin binomial	Comments
Not available	 Photo 3-52: Pectoral sandpiper	*Calidris melanotos*	Pectoral sandpipers (Photo 3-52) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Pectoral sandpipers are medium sized, chunky shorebirds. They are found most commonly on mudflats with short grass or weedy vegetation. They breed across Alaska, northern Canada, and northeastern Siberia. They winter inland in South America with small numbers in the south Pacific and southeast Asia (Cornell Lab of Ornithology 2008).
Not available	 Photo 3-53: Least sandpiper	*Calidris minutilla*	Least sandpipers (Photo 3-53) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Least sandpipers are the smallest shorebirds in the world. They breed throughout Alaska and northern Canada eastward to Newfoundland. These birds winter from Oregon and New Jersey southward to central South America and migrate to wet meadows, mudflats, flooded fields, shores of pools and lakes, and less frequently to sandy beaches (Cornell Lab of Ornithology 2008).
Not available	 Photo 3-54: Dunlin	*Calidris alpina*	Dunlins (Photo 3-54) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Dunlins are medium-sized sandpipers that breed across the top of North America and Eurasia and winter along coasts around the northern hemisphere. They winter along mudflats, estuaries, marshes, flooded fields, sandy beaches, and shores of lakes and ponds (Cornell Lab of Ornithology 2008).
Not available	 Photo 3-55: Curlew sandpiper	*Calidris ferruginea*	Curlew sandpipers (Photo 3-55) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Curlew sandpipers are medium-sized shorebirds which breed on the tundra of Arctic Siberia. They are strongly migratory, wintering mainly in Africa, but also in south and southeast Asia and in Australasia.

Table 3-11: Summary of Migratory Birds Observed at PHNC (Continued)

Hawaiian Name	Photograph/Common Name	Latin binomial	Comments
Huna kai	 Photo 3-56: Sanderling	*Calidris alba*	Sanderlings (Photo 3-56) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Sanderlings are small, plump sanderlings or sandpipers. They are well-known for their habit of foraging at the edge of the surf zone and running up and down the beach to avoid waves while probing the sand for invertebrates. The sanderling is indigenous to Hawai'i. They winter in Hawai'i (as well as other locations) and prefer to forage on sandy beaches, tidal flats, and mudflats. The most severe threats to this species are considered environmental. Global warming is expected to have the greatest impact on breeding populations. The greatest threats for wintering birds in Hawai'i include loss and degradation of habitat and avian disease (DOFAW 2005).
Not available	 Photo 3-57: Bar-tailed godwit	*Limosa lapponica*	Bar-tailed godwit (Photo 3-57) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). The breeding habitat of bar-tailed godwits ranges from Arctic Asia and western Alaska on the open tundra. They migrate in flocks to coastal western Europe, Africa, South Asia, Australia, and New Zealand. These birds forage in mudflats or marshes. They mainly eat insects and crustaceans, but also eat parts of aquatic plants.
Not available	 Photo 3-58: Black-tailed godwit	*Limosa limosa*	Black-tailed godwits (Photo 3-58) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Black-tailed godwits are large shorebirds that breed in temperate wetlands in Europe and Asia on open grassland. They migrate in flocks to western Europe, Africa, south Asia, and Australia. They forage on mudflats and marshes eating insects and crustaceans as well as parts of aquatic plants.

Table 3-11: Summary of Migratory Birds Observed at PHNC (Continued)

Hawaiian Name	Photograph/Common Name	Latin binomial	Comments
Not available	 Photo 3-59: Marsh sandpiper	*Tringa stagnatilis*	Marsh sandpipers (Photo 3-59) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Marsh sandpipers are small waders that breed in open grassy steppe and taiga wetlands from easternmost Europe to central Asia. The majority of this migratory species winters in Africa and India with fewer migrating to southeast Asia and Australia. These birds forage in shallow water or on wet mud for insects and similar small prey.
Not available	 Photo 3-60: Greater yellowlegs	*Tringa melanoleuca*	Greater yellowlegs (Photo 3-60) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Greater yellowlegs are large North American shorebirds that breed in wet bogs with small wooded islands, muskeg, and forests with abundant clearings in southern Alaska and central Canada eastward to Newfoundland. They winter in southern U.S. southward to southern South America, northward along the coasts to southern British Columbia and Connecticut. They winter in a wide variety of shallow fresh and saltwater habitats (Cornell Lab of Ornithology 2008).
Not available	 Photo 3-61: Lesser yellowlegs	*Tringa flavipes*	Lesser yellowlegs (Photo 3-61) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Lesser yellowlegs are medium-sized shorebirds that breed across Alaska and northern Canada eastward to Quebec. They winter in southern U.S., northward along the coasts to southern central California and New Jersey. They winter in a variety of shallow fresh and saltwater habitats. They are active foragers and eat aquatic and terrestrial invertebrates and occasionally small fish and seeds (Cornell Lab of Ornithology 2008).

Table 3-11: Summary of Migratory Birds Observed at PHNC (Continued)

Hawaiian Name	Photograph/Common Name	Latin binomial	Comments
ʻŪlili	 Photo 3-62: Wandering tattler	*Heteroscelus incanus*	Wandering tattlers (Photo 3-62) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Wandering tattlers are indigenous to Hawai'i where they winter. Adults arrive from July to August and Juveniles from September to November. These birds forage in intertidal habitats such as coral reefs and less frequently in soft mud or sand. They may also forage along mountain streams, in wetlands, fish ponds, and human-modified areas. Primary threats to the species include avian disease and loss of wetland habitat to habitat-modifying invasive plants, development, and pollution (DOFAW 2005).
Not available	 Photo 3-63: Ruff	*Philomachus pugnax*	Ruffs (Photo 3-63) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Ruffs are medium-sized waders that breed in bogs, marshes, and wet meadows with short vegetation in northern Europe and Russia. Ruffs are migratory, wintering in southern and western Europe, Africa, and India.
Not available	 Photo 3-64: Black-bellied plover	*Pluvialis squatarola*	Black-bellied plovers (Photo 3-64) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Black-bellied plovers are large shorebirds of coastal beaches. They breed along the Arctic coast, from western Alaska to Baffin Island and across northern Eurasia. They winter from British Colombia and Massachusetts southward along coasts of the U.S. and Central America, Bermuda, and the West Indies, to southern coastal South America and also from southern Europe and Asia to southern Africa, Australia, and New Zealand. They winter on coastal beaches and estuaries and may use flooded pasture and agricultural land (Cornell Lab of Ornithology 2008).

Table 3-11: Summary of Migratory Birds Observed at PHNC (Continued)

Hawaiian Name	Photograph/Common Name	Latin binomial	Comments
Kōlea	 Photo 3-65: Pacific golden plover	*Pluvialis fulva*	Pacific golden plovers (Photo 3-65) were observed at Makalapa Crater, NAVMAG PH West Loch Branch, Waipi'o Peninsula, and PHNWR in 2006 (NAVFAC PAC 2006a). Pacific golden plovers are medium-sized plovers that are indigenous to Hawai'i. During the winter months, they occupy upland and coastal habitats in the Hawaiian Islands. They leave Hawai'i in April to migrate to Alaska to breed and return to Hawai'i in August. Hunting was a significant threat to the species until 1941 when it was prohibited. On golf courses in Hawai'i, these birds may come into contact with pesticides and herbicides, which may be harmful (DOFAW 2005).
Not available	 Photo 3-66: Semi-palmated plover	*Charadrius semipalmatus*	Semi-palmated plovers (Photo 3-66) were observed at PHNWR in 2006 (NAVFAC PAC 2006a). Semi-palmated plovers are small plovers that utilize open ground on beaches or flats across northern Canada and Alaska for breeding habitat. They are migratory birds and winter in coastal areas ranging from the U.S. to Patagonia. These birds forage for food on beaches, tidal flats, and fields, eating insects, crustaceans, and worms.

Table 3-11: Summary of Migratory Birds Observed at PHNC (Continued)

Hawaiian Name	Photograph/Common Name	Latin binomial	Comments
'Akekeke	 Photo 3-67: Ruddy turnstone	*Arenaria interpres*	Ruddy turnstones (Photo 3-67) were observed at NAVMAG West Loch and PHNWR in 2006 (NAVFAC PAC 2006a). Ruddy turnstones are small, calico-colored shorebirds that are indigenous to Hawai'i. This species breeds in the coastal areas and inland interiors of the Arctic Circle and winter on the shorelines of the MHI. While in Hawai'i, they are almost exclusively coastal, foraging mostly along stony or rocky shorelines with abundant seaweed and commonly on sandy shorelines and in mudflats and river deltas. Across most of their winter range, primary threats are human industrial and recreational activity leading to habitat loss and degradation by means of chemical contamination and disturbance. Avian diseases are also a threat (DOFAW 2005).
Not available	 Photo 3-68: Peregrine falcon	*Falco peregrinus*	NAVFAC PAC biologists observed peregrine falcon (Photo 3-68) at PHNWR (NAVFAC PAC 2006a). Peregrine falcons are medium-sized falcons; they breed locally from Alaska to Greenland and southward to Mexico, Missouri, and northern Georgia as well as other locations in the world. They winter from coastal Alaska and southern Canada southward to South America and can be found in a variety of habitats, most with cliffs for nesting and open areas for foraging. They eat mostly birds from song birds up to small geese as well as bats and small mammals (Cornell Lab of Ornithology 2008).

Table 3-11: Summary of Migratory Birds Observed at PHNC (Continued)

Hawaiian Name	Photograph/Common Name	Latin binomial	Comments
Not available	 Photo 3-69: Osprey	*Pandion haliaetus*	NAVFAC PAC biologists observed an osprey (Photo 3-69) flying over Pearl Harbor (Waipi'o Peninsula and PHNWR) in 2005 (NAVFAC PAC 2006a). Ospreys are one of the largest birds of prey in North America; they almost exclusively eat fish. They are one the most widespread birds in the world, found on all continents except Antarctica. They breed in Alaska across Canada, southward locally and along coasts to Mexico and Caribbean as well as Eurasia, Middle East, Australia, and Indonesia. They winter from the southern U.S. southward to South America as well as Africa, India, southeast Asia, and Australia. They winter along large bodies of water containing fish (Cornell Lab of Ornithology 2008).

Source: NAVFAC 2006a and DOFAW 2005; photo credits: see Chapter 9

3.3.4.2 Mammalian Species

1. Pearl Harbor: A feral mammal survey was not completed for the Pearl Harbor shoreline. However, feral cats at PHNWR have been a problem. The PHNWR refuge manager has requested the Navy's assistance in deterring people from feeding feral cats in the vicinity of the refuges. The Navy intends to expand on its current policy (Appendix I7, Preventing Feral Cat and Dog Populations on Navy Property) to create a specific educational plan on the negative effects of feral cats on native wildlife (Section 9.4).

2. Makalapa Crater: Feral mammal surveys were conducted at Makalapa Crater in 1998 and in 2006. Mammals documented include: (1) small Indian mongoose; and (2) cats. Black rats (*Rattus rattus*) were observed during the 2006 survey only. The federally-listed endangered, endemic Hawaiian hoary bat (*Lasiurus cinereus semotus*) are known to occur on O'ahu but were not observed at Makalapa Crater; however, they use a variety of habitats including native forest, ranchlands, ponds, and bays as well as urban areas; they could visit the site (Bruner 1999). Rat numbers appear to be low at Makalapa Crater; however, trap interference (probably from mongoose) did occur and the rat densities could be higher. Feral mongoose and cats were abundant (NAVFAC PAC 2006d).

3. Pearl City Peninsula: Small Indian mongoose and feral cats were recorded at the Pearl City Peninsula during the 2000 feral mammal survey. Cats and mongoose are significant bird predators. Although not observed, rats and mice likely occur at Pearl City Peninsula. Although the federally-listed endangered Hawaiian hoary bat occurs in low numbers on O'ahu, no bats were observed during the survey (Bruner 2000).

4. Red Hill Fuel Storage Area. Feral mammal surveys were conducted at Red Hill Fuel Storage Area in 1999/2000 (Bruner 2000) and 2006 (NAVFAC PAC 2006d). Small Indian mongoose and feral cats were recorded at the Red Hill Fuel Storage Area during the 2000 feral mammal survey. Cats and mongoose are significant bird predators. Black rats were documented during the 2006 survey and although not observed, mice likely occur at the site. Although the federally-listed endangered Hawaiian hoary bat occurs in low numbers on O'ahu, no bats were observed during the survey (Bruner 2000). During the 2006 survey, feral pigs were documented at the site and were considered abundant (NAVFAC 2006d).

5. Waiawa Watershed: Feral mammal surveys were conducted at Waiawa Watershed in 1999 (Bruner 2000) and 2006 (NAVFAC PAC 2006d). Small Indian mongoose were recorded at the Waiawa Watershed during the 2000 feral mammal survey. Mongoose are significant bird predators. Black rats were documented during the 2006 survey and, although not observed, mice likely occur at the site. The federally-listed endangered Hawaiian hoary bat occurs in low numbers on O'ahu; however, no bats were observed during the survey (Bruner 2000). During the 2006 survey, feral pigs were documented at the site and are considered abundant (NAVFAC 2006d).

6. West Loch/Waipi'o Peninsula. NAVFAC PAC biologists performed a mammal survey on Navy lands at Waipi'o Peninsula in 2006. They noted the presence or likely presences of three mammals: (1) feral cats; (2) mongooses; and (3) rats (NAVFAC PAC 2006d). In addition, a 1985 wildlife study found two other species of mammals: (1) house mouse (*Mus Musculus*); and (2) feral dogs (*Anis familiaris*). None of these are indigenous to Hawai'i or are rare, threatened, or endangered species.

3.3.4.3 Amphibian and Reptile Species

1. Pearl Harbor Shoreline: An amphibian and reptile species survey was not conducted for the Pearl Harbor shoreline; the Navy focused amphibian and reptile species (herpetological) surveys on forested areas where these species are of more interest from an ecological/invasive species perspective.

2. Makalapa Crater: An amphibian and reptile species (herpetological) survey was conducted at Makalapa Crater in 2006. Reptiles documented at the site include the house gecko (*Hemidactylus frenatus*) and mourning gecko (*Lepidodactylus lugubris*). Neither of the documented species are considered to be native or protected (NAVFAC PAC 2006d).

3. Pearl City Peninsula: An amphibian and reptile species (herpetological) survey was conducted at Pearl City Peninsula in 2006. Reptiles documented at the site include the house gecko and mourning gecko. None of the documented species are considered to be native or protected (NAVFAC PAC 2006d).

4. Waiawa Watershed: An amphibian and reptile species (herpetological) survey was conducted at Waiawa Watershed in 2006. Reptiles documented at the site include the house gecko, the mourning gecko, and the Indo-Pacific gecko (*Hemidactylus garnotii*). None of the documented species are considered to be native or protected (NAVFAC PAC 2006d).

5. West Loch/Waipi'o Peninsula. An amphibian and reptile species survey (herpetological) was performed at West Loch (NAVFAC PAC 2006d). That survey noted the presence of two reptiles at Waipi'o Peninsula: (1) house gecko; and (2) mourning gecko. These reptiles were considered to be abundant and are an introduced species.

3.3.4.4 Freshwater Species

NAVFAC PAC performed a survey of a portion of Waiawa Stream on Navy property for aquatic species (NAVFAC PAC 2007c). The primary purpose of the survey was to determine if native Hawaiian damselflies (*Megalagrion* sp.) were present in the area. No adult or immature damselflies were observed or caught in the portion of the stream that flows on Navy land. The only member of the *Odonta* (order of insects comprised of dragonflies and damselflies) found in this portion of the stream was the dragonfly *Pantala flavescens*. This species is indigenous to Hawai'i and is commonly found around ponds, slow moving streams, and temporary pools. The only other aquatic indigenous species was *Awaous guamensis* or 'o'opu nākea. This fish represents Hawai'i's largest native goby. It is not considered to be endemic to Hawai'i as it occurs naturally in other locations in the Pacific. In addition to the two indigenous species, five other alien species were recorded: (1) Chinese catfish (*Clarias fuscus*); (2) topminnows (*Poeciliidae spp.*); (3) cane toad tadpole (*Bufo marinus*); (4) bullfrog tadpole (*Rana catesbeiana*); and (5) Tahitian prawn (*Macrobrachium lar*) (NAVFAC PAC 2007c).

3.3.4.5 Marine Species

The discussion of marine animal species at PHNC is divided into three subsections: (1) marine mammals; (2) sea turtles; and (3) corals, fishes, and macroinvertebrates.

1. Marine Mammals

Marine mammals found in Hawaiian waters include the endangered Hawaiian monk seal and humpback whale (Section 3.1.1.1), as well as various toothed whales that are not listed as threatened or endangered.

2. Sea Turtles

All sea turtles are protected under the federal ESA and further discussion is presented in Section 3.3.1.1.

3. Corals, Fishes, and Macroinvertebrates

Coral resources are discussed in depth in Chapter 8, Coral Insert. A summary is presented here. Historically, Pearl Harbor has had significant fishery resources and, under the jurisdiction of the Navy, has allowed fishery resources to exist with little or no fishing pressure. The exception has been the permits issued to the live-bait skipjack tuna (aku) vessels seeking bait in the harbor. This industry has declined in recent years due to changes in the industry and the prevalence of long-line fishing techniques. Aku vessel access to Pearl Harbor ceased after September 11, 2001. Most other types of commercial fisheries and aquaculture are not compatible with the Navy's military mission and security concerns for Pearl Harbor.

A characterization of fish and benthic communities of Pearl Harbor and the PHEC was completed in September 2005 (Smith *et al.* 2006). Selected marine resources, including corals, fishes, and sea turtles, were assessed at 18 sites within Pearl Harbor and at 11 sites in or adjacent to the PHEC (Figures 3-24 and 3-25). The assessments were conducted in relatively small areas and resulted in detailed, site-specific information.

Photo 3-70: Pocillopora damicornis

Photo 3-71: coral partially covered with gorilla seaweed.

Coral Species. It is difficult to make comparisons on the presence/absence or relative abundance of different coral species in Pearl Harbor based on historical surveys; however, assuming all surveys covered similar types of habitats, as shown in Table 3-12, the diversity of coral species with Pearl Harbor, and the PHEC has possibly increased in recent years. Studies conducted during 1973 and 1974 did not note the presence of any stony corals in Pearl Harbor. However in 1999, five stony coral species were observed in Pearl Harbor including coral colonies in some of the areas previously studied in 1973 and 1974. Eight stony coral species were observed in 2002 with one or more species present at five of the 1973/1974 study locations. The 2005 marine assessment (Smith *et al.* 2006) noted the presence of three additional hard coral species. *Pocillopora damicornis* (Photo 3-70) was the most dominant scleractinian species in the 2002 and 2005 studies whereas *Leptastrea purpurea* was the most common coral in the 1999 study. However, nearly all of the coral colonies revisited in the 2005 were partially or completely covered with gorilla seaweed (*Gracilaria salicornia)* (Photo 3-71). The total number of stony corals and diversity of species within Pearl Harbor appears to have increased substantially since 1974. Unfortunately, the dramatic increase in gorilla seaweed in the coral colonies between 2002 and 2005 is of great concern. This alga has devastated corals in many areas of Hawai'i and its presence in Pearl Harbor will adversely impact stony coral growth and recruitment, and the general macrobenthic invertebrate diversity and fish stocks (Smith *et al.* 2006).

The habitat in the surveyed portion of the Fort Kamehameha WWTP Outfall Corridor (within PHEC) was depauperate from the perspective of stony corals prior to construction of the outfall as well as during the 2005 marine assessment (Smith *et al.* 2006). The trenching of the outfall pipe in that portion of PHEC has not significantly altered that portion of the PHEC's ability to support corals. Substrate composition and stability were the most important limiting factors prior to construction of the outfall extension and remained the most important limiting factors in 2005 (Smith *et al.* 2006).

Table 3-12: Coral Species Observed in Pearl Harbor and PHEC 1999-2010

Coral Species	Years Observed			
	1999	2002	2006	2010
Montipora patula	X	X	X	X
Montipora capitata		X	X	X
Montipora flabellata		X	X	X
Montipora dilatata				X
Leptoseris incrustans			X	X
Cyphastrea ocellina				X
Cyphastrea ocellina				X
Pavona varians			X	X
Leptastrea purpurea	X	X	X	X
Pocillopora damicornis	X	X	X	X
Pocillopora meandrina	X	X	X	X
Porites compressa	X	X	X	X
Porites lobata		X	X	X

Psammocora explanulata			X	X

Source: Smith *et al.* 2006, NFESC 2010

No portion of the PHEC channel seafloor supports significant coral growth. However, quantities of stony coral increase in the seaward direction of the channel. The inner portions of PHEC are composed of higher percentages of fine sand and mud and are barely marginal for coral development and the substrate is even less well suited for coral recruitment. However, scattered metallic and concrete debris in the PHEC does support moderate to good coral growth at all points within the PHEC (Smith *et al.* 2006).

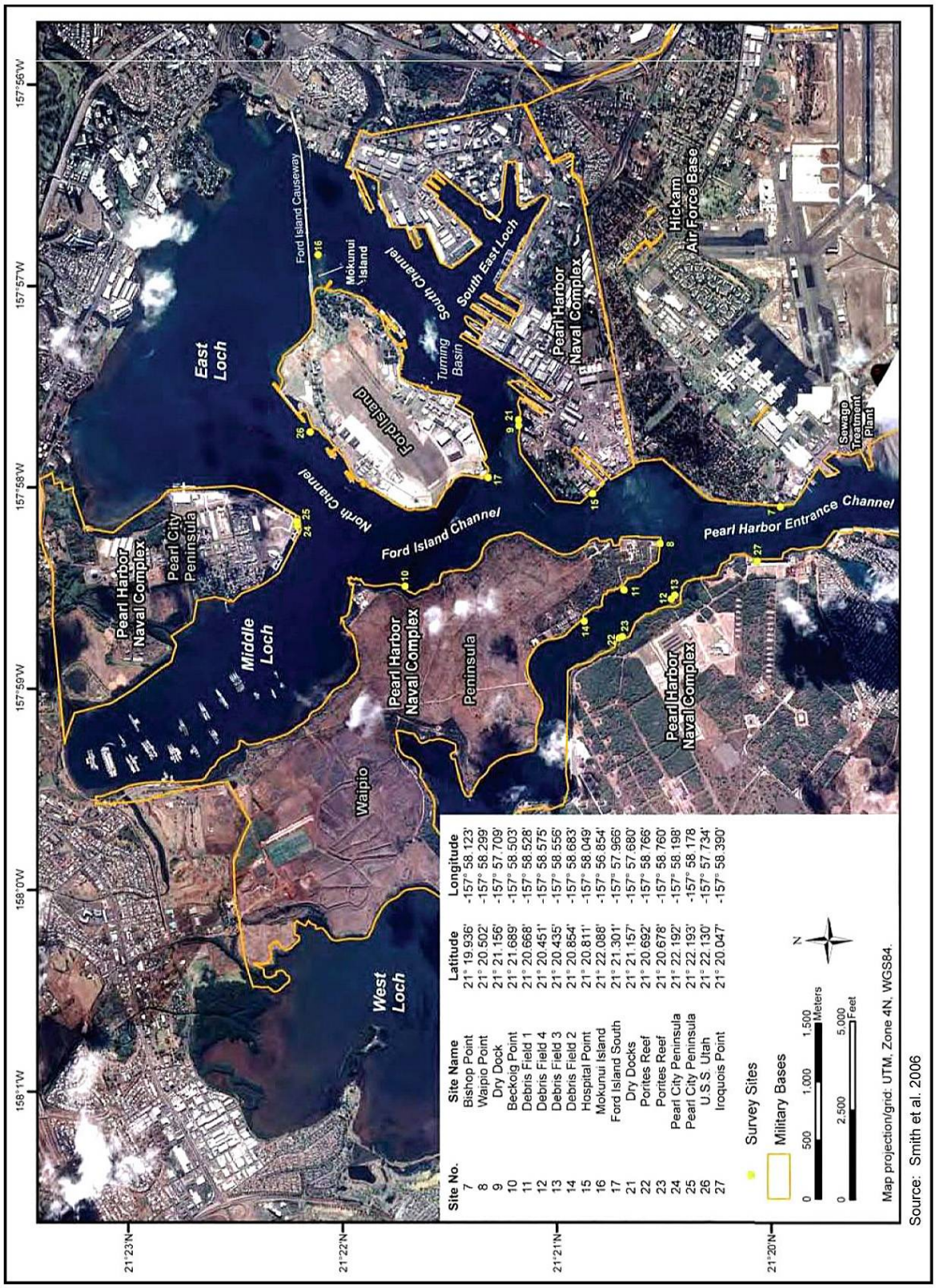
Fishes. The 2005 Marine Assessment noted the presence of 90 species of fishes from 26 families. Within Pearl Harbor, 48 fish species were recorded in 24 transects and 64 species were recorded in seven transects within PHEC (Smith *et al.* 2006). Appendix B3 provides a listing of the fish species, by family, observed in Pearl Harbor and PHEC. None of the fish species encountered were unusual or rare; however, sizes of many individuals of some species were unusually large (Smith *et al.* 2006).

As noted in Smith *et al.* (2006), coral reef fishes are usually more abundant in areas where shelter is more available. Both the number of individual fish and standing crop of fishes in Pearl Harbor debris field transects are significantly greater than any of the other three transect groupings (channel walls, entrance channel, and sediment bottom). Appendix B3 provides summaries of the marine animal species and number of individual fish species observed for each location surveyed as part of the 2005 Marine Assessment.

Macroinvertebrate Communities. Benthic data was collected at a total of 20 of the 29 sites within PHEC and Pearl Harbor (Appendix B3). Ten of the transects were on sediment substrates, seven along the walls in the harbor, and four in debris fields in Pearl Harbor. Mean total live cover averaged for all five of the Pearl Harbor sites was 9.97 percent. Live coral and sponge cover were highly variable. Debris Field 2 had the highest mean total live cover at 34.31 percent with 27.5 percent attributed to sponge cover. Live cover was dominated by turf algae.

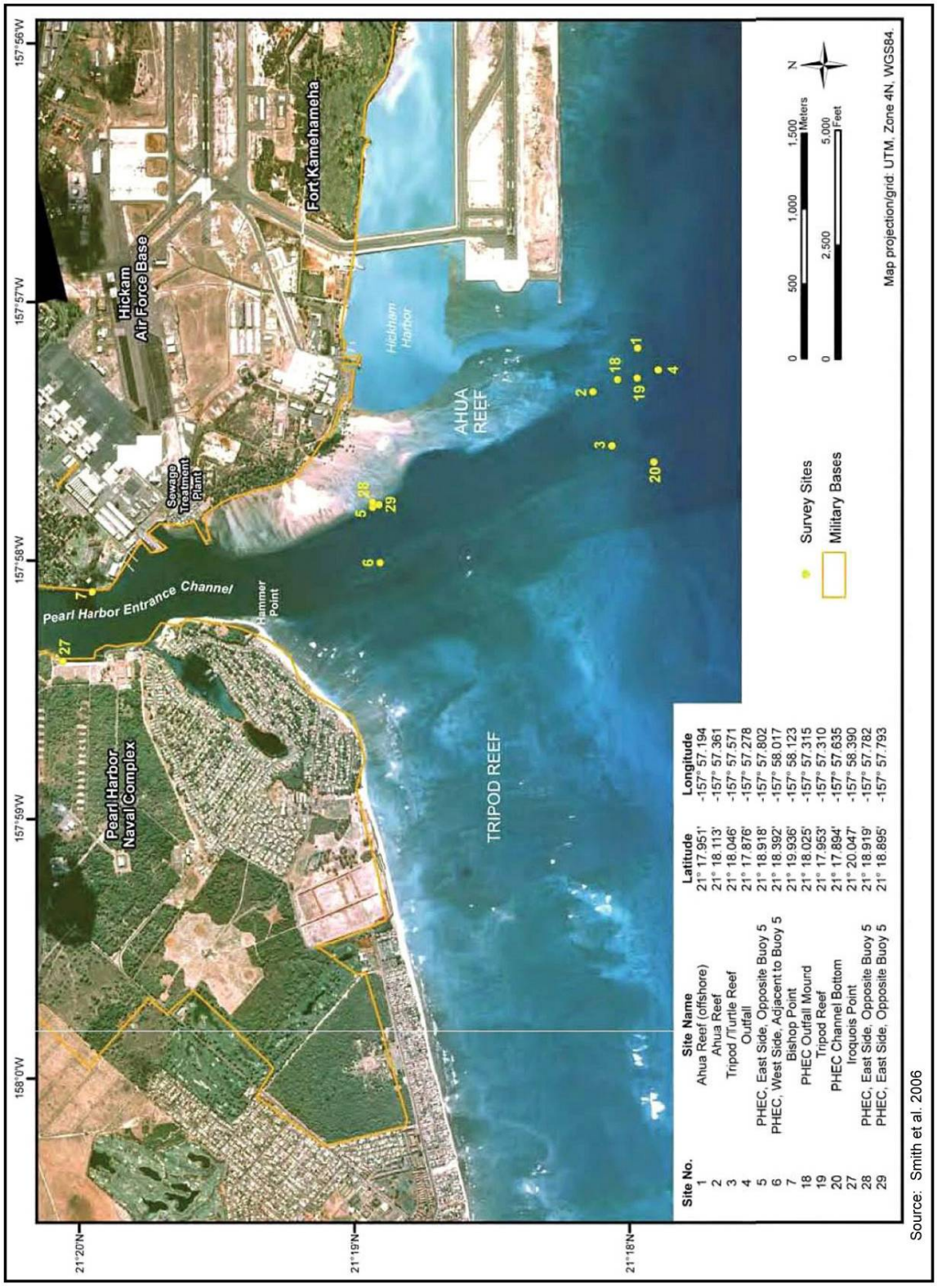
Excluding the Fort Kamehameha WWTP outfall, five sites within PHEC were surveyed and assessed for the presences of live coral, zoanthid, sponge, oyster, echinoid, annelid, crustacean, and tunicate cover. These sites included: (1) Site 1 Ahua Reef Offshore (hard bottom substrate); (2) Site 2 Ahua Reef (hard bottom substrate); (3) Site 3 Tripod Reef (hard bottom substrate); (4) Site 5 PHEC Opposite Buoy 5 (hard bottom substrate); and (5) Site 6 PHEC, West at Buoy 5 (unconsolidated substrate). The mean total live cover percentage for each site was variable. Site 6 had the lowest live cover and Site 5 had the highest (Appendix B3).

A quantitative assessment of the benthos on the sunlit portion of a 164 ft (50 m) section of the Fort Kamehameha WWTP outfall pipe and piles was conducted in September 2005, approximately two years after the pipe emplacement. Turf algae covered almost the entire sunlit portion of the pipe. Hard coral, small patches of crustose coralline algae, and small areas colonized by encrusting sponges were located along the pipe. The density of coral colonies was relatively low and highly variable. Corals were represented by three species from three genera, *Pocillopora meandrina*, *Porites sp.*, and *Montipora sp.* Similar to the pipe, the sessile benthos observed on the five concrete support piles surveyed consisted of turf algae. The remaining sessile cover included highly variable cover values of hard corals, encrusting sponges, crustose coralline algae, and sessile bivalves.



Site No.	Site Name	Latitude	Longitude
7	Bishop Point	21° 19.936'	-157° 58.123'
8	Waipio Point	21° 20.502'	-157° 58.299'
9	Dry Dock	21° 21.156'	-157° 57.709'
10	Beckoig Point	21° 21.689'	-157° 58.503'
11	Debris Field 1	21° 20.668'	-157° 58.528'
12	Debris Field 4	21° 20.451'	-157° 58.575'
13	Debris Field 3	21° 20.435'	-157° 58.556'
14	Debris Field 2	21° 20.854'	-157° 58.683'
15	Hospital Point	21° 20.811'	-157° 58.049'
16	Mokunui Island	21° 22.088'	-157° 56.854'
17	Ford Island South	21° 21.301'	-157° 57.966'
21	Dry Docks	21° 21.157'	-157° 57.680'
22	Porites Reef	21° 20.692'	-157° 58.766'
23	Porites Reef	21° 20.678'	-157° 58.760'
24	Pearl City Peninsula	21° 22.192'	-157° 58.198'
25	Pearl City Peninsula	21° 22.193'	-157° 58.178'
26	U.S.S. Utah	21° 22.130'	-157° 57.734'
27	Iroquois Point	21° 20.047'	-157° 58.390'

Figure 3-24: Marine Survey Sites within Pearl Harbor



Site No.	Site Name	Latitude	Longitude
1	Ahua Reef (offshore)	21° 17.951'	-157° 57.194
2	Ahua Reef	21° 18.113'	-157° 57.361
3	Tripod /Turtle Reef	21° 18.046'	-157° 57.571
4	Outfall	21° 17.876'	-157° 57.278
5	PHEC, East Side, Opposite Buoy 5	21° 18.918'	-157° 57.802
6	PHEC, West Side, Adjacent to Buoy 5	21° 18.392'	-157° 58.017
7	Bishop Point	21° 19.936'	-157° 58.123
18	PHEC Outfall Mound	21° 18.025'	-157° 57.315
19	Tripod Reef	21° 17.953'	-157° 57.310
20	PHEC Channel Bottom	21° 17.894'	-157° 57.635
27	Iroquois Point	21° 20.047'	-157° 58.390
28	PHEC, East Side, Opposite Buoy 5	21° 18.919'	-157° 57.782
29	PHEC, East Side, Opposite Buoy 5	21° 18.895'	-157° 57.793

Figure 3-25: Marine Survey Sites within PHEC

3.3.5 Vegetation

The discussion of vegetation within PHNC focuses on the terrestrial vegetation within the six areas with significant natural resources value: (1) Pearl Harbor; (2) Makalapa Crater; (3) Pearl City Peninsula; (4) Red Hill Storage Area; (5) Waiawa Watershed; and (6) West Loch/Waipi'o Peninsula. Vegetation in the developed areas of PHNC, including the Navy family housing communities, consists largely of exotic imported grasses and trees maintained by intensive landscape maintenance. Most of the landscaped areas are located around buildings, along main roads, and within the recreation and family housing areas. The landscape vegetation bears little resemblance to the annual grasses, trees, and shrubs originally found in the area. Native vegetation exists only on small, semi-improved, and unimproved areas.

Botanical surveys of the Pearl Harbor (Mangrove Community), Makalapa Crater, the Red Hill Fuel Storage Area, and the Waiawa Watershed were completed for the 2001 INRMP (Char 1999; 2000a, b, c). A botanical survey for the Pearl Harbor Coastal Zone and an update to the botanical survey for Waiawa Watershed were completed in 2006 (NAVFAC PAC 2006b).

3.3.5.1 Pearl Harbor Shoreline

In 1999 and 2000, a botanical survey was conducted along the Pearl Harbor shoreline in the vicinity of Loko 'Oki'okiolepe, Loko Pa'aiau, the shoreline around Waipi'o Peninsula and Pearl City Peninsula (Char 2000c). An update to the earlier survey was conducted in 2006 and included Waipi'o and Pearl City Peninsulas as well as Laulaunui Island (NAVFAC PAC 2006b). The Pearl Harbor shoreline is dominated by non-native plant species. The plants surveyed during the 1999/2000 and 2006 surveys were not federally- or SOH-listed as threatened or endangered species, nor were there any plant species of concern (Char 2000c; NAVFAC PAC 2006b).

Along the Pearl Harbor shoreline, the mangrove community is the dominant plant community. The original, low growing native vegetation composed of various sedges has been replaced by mangrove. In Hawai'i, mangroves are viewed as invasive and their negative ecological and economic impacts are well reported (NAVFAC 2006b). Mangrove has drastically altered the ecology of the Pearl Harbor's coastal zone changing the water flow patterns in the harbor. The invasion of mangrove into Pearl Harbor's wetlands has resulted in fewer open, shallow marshlands and mudflats utilized by federally-listed endangered Hawaiian waterbirds and MBTA-protected birds and adversely impacting cultural resources such as fishponds (Loko Pa'aiau, Loko Laulaunui, Loko 'Oki'okiolepe, Loko Pamoku). In addition, mangroves also adversely impact protected bird species by providing habitat for predators including rats, mongoose, and predatory birds (Char 2000c). Mangrove stands are reportedly used by homeless persons for shelter and vandals at the Waiawa Unit of the PHNWR (USFWS 2006). In recent years, the Navy removed a total of 59.5 acres of mangrove along the shoreline in an effort to improve harbor security (CNRH Environmental 2007). In addition, mangrove has been removed by the USFWS at the Waiawa Unit of the PHNWR in order to increase habitat for protected bird species (USFWS 2006).

In undeveloped areas along the shoreline with estuarine, intertidal habitats, mangrove is the dominant plant cover. Other plant communities are found adjacent to and inland of the dense mangrove thickets. Pickleweed marsh is found in low-lying areas behind the mangrove. In addition, kiawe (*Prosopis pallida*) forests occurs as a narrow band along the shorelines of West Loch and the lower half of Waipi'o Peninsula. Koa haole (*Leucaena leucocephala*) is found inland of the mangroves on the western portion of the Pearl City Peninsula (Char 2000c).

Mangroves occur in relatively sheltered, shallow water along the undeveloped portions of Pearl Harbor. These are areas of mudflats, embayments, at the mouths of streams, and around fishponds where there are diurnal and seasonal fluctuations of flooding and salinity. Dense stands of trees from 20 to 40 ft (6 to 12 m) tall can be found with some inland areas where the trees may reach 50 to 60 ft (15 to 18 m) in height. A dense carpet of leaf litter and propagules as well as exposed substrate, usually mud or coral and shell rubble, can be found under the mangrove trees (Char 2000c).

Along the margins of mangrove thickets, other species can be found in very small numbers. Scattered milo trees (*Thespesia populnea*) and small patches of pickleweed can be found at Loko Pa'aiau at McGrew Point and hau (*Hibiscus tiliaceus*), Indian fleabane (*Pluchea indica*), and mats of California grass (*Brachia mutica*) are found along Waiawa Stream. In addition, on the inland side of most mangrove thickets, a few kiawe and milo trees are usually found. Dense mats of pickleweed can be found on the margins of ponds at the Waiawa and Honouliuli Units of the PHNWR. Kiawe forest is found inland of the mangrove community at Loko Pa'aiau. It comprises about 50 percent of the tree cover while 'opiuma (*Pithcellobium dulce*), monkeypod (*Samanea saman*), milo, and coconuts (*Cocos nucifera*) make up the remaining tree cover. In addition, shrubs of koa haole, Christmas berry (*Schinus terebinthifolius*), and Indian fleabane are common to abundant (Char 2000c).

Koa haole scrub is not a wetland indicator species in Hawai'i, but can be found directly inland of the mangrove community in some places on Waipi'o Peninsula and Pearl City Peninsula. On Pearl City Peninsula, koa haole scrub is found bordering the mangrove community along both sides of Waiawa Stream. Ground cover is generally Guinea grass (*Panicum maximum Jacq*.) and scattered patches of pitted beardgrass (*Bothriochloa pertusa*), Australian saltbush (*Atriplex semibaccata R. Br*), and swollen fingergrass (*Chloris barbata*) (Char 2000c).

On Laulaunui Island, located in the West Loch, the vegetation is similar to the surrounding coastal areas of West Loch and Pearl City Peninsula. A large portion of the island is a Hawaiian fish pond, which is surrounded by thick impenetrable mangrove forest. Other than mangrove, the predominant community is kiawe. The ground cover is comprised primarily of thick beds of indigenous 'ilima (*Sida fallax*); however, this shows evidence of being overtaken by the very invasive golden crown beard (*Verbesina enceloides*). Pā'ū o Hi'iaka (*Jacquemontia ovalifolia* spp. *Sandwicensis*) is the other native ground cover observed on the island. Non-native ground cover includes lion's ear (*Leonotis nepetifolia*), coral berry (*Ravina humilis*), *Boerhavia cocinea*, and ivy gourd (*Coccina grandis*). The non-native sourbush (*Pluchea carolinensis*), India fleabane, and koa haole were the most common shrubs observed.

3.3.5.2 Makalapa Crater

A botanical survey of the interior of Makalapa Crater was completed in 1999 (Char 1999). The interior of Makalapa Crater is one of the few areas within PHNC that has not been developed and still has some remaining natural resources. The vegetation within the crater interior is dominated by introduced and alien species such as kiawe, koa haole, and buffelgrass (*Cenchrus ciliaris*). Only three native species occur on the site: (1) Kauna'oa or native dodder (*Cuscuta sandwichiana*); (2) 'ilima ; and (3) pōpolo (*Solanum americanum*). A few low-lying spots support pickleweed and California grass, both of which are wetland indicator species. The plants surveyed were not federally- and/or SOH-listed as threatened or endangered species, nor were there any plant species of concern. All of the plants can be found in similar environmental habitats throughout the Hawaiian Islands (Char 1999).

Kiawe trees form a closed-canopy forest on the north and east portions of the crater. Wild date palm (*Phoenix sylvestris*), monkeypod, 'opiuma, sebesten plum (*Cordia dichotoma*), and yellow poinciana (*Peltophorum inerme*) are some of the large trees that are scattered in the kiawe forest. The understory vegetation consists of scattered shrubs of koa haole and dense tufts of Guinea grass, and green panicgrass (*Panicum maximum* var. *trichoglume*) (Char 1999).

Along the southern boundary, 'opiuma trees are locally abundant and form rather large stands of trees, 15 to 20 ft (5 to 6 m) tall. Thickets of koa haole shrubs are also common. Buffelgrass forms a dense mat between woody components in open areas. Weedy annual plants such as hairy spurge (*Chamaesyce hirta*), coat buttons (*Tridax procumbens*), *Boerhavia coccinea*, swollen fingergrass, sowthistle (*Sonchus oleraceus*), and false mallow (*Malvastrum coromandelianum*) were observed in the overgrown trails and dirt roads that cross the open kiawe forest. *Sida ciliaris*, an introduced weed, was observed along the crushed coral-lined road that parallels the H-1 Freeway. On the south and west a portion of the crater, the kiawe forest is open and the trees are 10 to 20 ft (3 to 6 m) tall (Char 1999).

3.3.5.3 Pearl City Peninsula

A botanical survey of Pearl City Peninsula was conducted in 1999/2000 (Char 2000c) and updated in 2006 (NAVFAC PAC 2006b). The majority of the peninsula is dominated by non-native plants. The plants surveyed were not federally- and/or SOH-listed, threatened or endangered species or species of concern.

On Pearl City Peninsula, koa haole scrub is found bordering the mangrove community along both sides of the Waiawa Stream. Along the east side of the stream, near the mouth, is a small embayment that is overgrown with mangrove. In this area, the koa haole scrub is more open and low, 4 to 6 ft (1.2 to 2 m) tall, with scattered kiawe trees. Shrubs of Indian fleabane are common. Ground cover is primarily Guinea grass and scattered patches of pitted beardgrass, Australian saltbush, and swollen finger grass. There are also patches of bare, reddish-colored soil (Char 2000c). The 2006 botanical survey update noted that conditions were largely the same as described in the 2000 botanical survey. The natural areas within Pearl City Peninsula are highly disturbed and weed dominated. Upstream along the Waiawa Stream, where salinity levels are lower, the stream is lined with typical riparian vegetation; including hau, India fleabane, and California grass. The northeastern corner of the peninsula, east of Lehua Avenue contained milo-dominated vegetation with a hau and naupaka (*Scaveloa sericea*) understory. Evidence of a milo harvest was also found in this area. Harvesting of milo is not condoned on Navy property and should be actively discouraged (NAVFAC PAC 2006b).

3.3.5.4 Red Hill Fuel Storage Area

A botanical survey of the Red Hill Fuel Storage Area was conducted in 2000 (Char 2000a) and an update was completed in 2006 (NAVFAC PAC 2006i). Portions of Red Hill Fuel Storage Area were extensively disturbed during the construction of the fuel tanks; however, vegetation has reestablished itself throughout these disturbed areas. A total of 125 plant species have been inventoried at the site, with 88 percent (110) being introduced species; one percent (1) being a Polynesian introduced species; and 11 percent (14) being native species. The plants surveyed at the Red Hill Fuel Storage Area are not federally- and/or SOH-listed as threatened or endangered or species of concern (Char 2000a; NAVFAC PAC 2006i).

The vegetation on the Red Hill Fuel Storage Area is typical of most lowland habitats on O'ahu with much of the site dominated by koa haole scrub and introduced plants. The vegetation along the ridge top has largely recovered from past construction activity, but there are eroded

(bare) areas mainly associated with the fuel storage tank vents. Five major vegetation types were recognized on the Red Hill Fuel Storage Area by Char (Char 2000a) and a sixth vegetation type mapped by NAVFAC PAC (2006i): (1) koa haole scrub; (2) open mixed scrub; (3) Christmas berry shrub; (4) open waiawī (*Psidium cattleianum* var. *littorale*) scrub; (5) ruderal vegetation; and (6) lowland mesic shrubland (NAVFAC PAC 2006i).

1. Koa haole scrub

Koa haole scrub occurs on gently sloping to somewhat steep slopes – especially on the lower eastern portion of the site. The koa haole shrubs form a tall, dense cover up to 20 ft (6 m) tall. Ground cover in areas with deeper soil consists primarily of Guinea grass with smaller localized patches of Chinese violet (*Asystasia gangetica*). Scattered through the koa haole scrub are small stands of trees, 20 to 40 ft (6 to 12 m) tall including Chinese banyan trees (*Ficus microcarpa*) and trees of silk oak (*Grevillea robusta*). Smaller numbers of Chinaberry (*Melia azedarach*), octopus tree (*Schefflera actinophylla*), autograph tree (*Clusia rosea*), and Java plum (*Syzygium cumini*) occur. Also, along the rock outcropped slopes are native ferns (kumuniu [*Doryopteris decipeins*]), lichens, a native peromia (*Peromia leptostachya*), and the native spurflower (*Plectranthus parviflorus*) (Char 2000a).

2. Mixed grass/shrub vegetation

Mixed grass/shrub vegetation can be found on the broad and gently sloping ridge top. This vegetation community includes open grassy sections (50 to 60 percent) colonized by shrubs (40 to 50 percent) such as koa haole, waiawī, lantana (*Lantana camara*), and Christmas berry, and a few trees of Java plum and silk oak. The grass cover is variable with large, robust clumps of Guinea grass (6 to 7 ft [1.8 to 2 m]), scattered mats of golden beardgrass or pilipili-'ula (*Chrysopogon aciculatus*), molasses grass (*Melinis minutiflora*), natal redtop (*Melinis repens*), pitted beardgrass, and broomsedge (*Andropogon virginicus*). There are several herbaceous species and small shrubs or subshrubs that are locally common – Spanish clover (*Desmodium incanum*), 'uhaloa (*Waltheria indica*), partridge pea (*Chamaecrista nictitans*), and Jamaica vervain (*Stachytarpheta jamaicensis*). Native species found include *'*uhaloa, golden beardgrass, 'ūlei (*Osteomeles anthyllidifolia*) which is shrubby member of the rose family, koa trees (*Acacia koa*), *'*akia (*Wikstroemia oahuensis*), alahe'e (*Psydrax odroratum*), *'*a'ali'i (*Dodonaea viscosa*), and huehue vines (*Cocculus orbiculatus*) (Char 2000a).

3. Christmas berry scrub

The Christmas berry scrub is found along the lower slopes of the site facing Moanalua Valley. The Christmas berry shrubs form dense thickets that exclude other plants. There are few other plants found in the understory and they generally occur along the margins. These include California grass, koa haole, sourbush, strawberry guava (*Psidium cattleianum*), Java plum, Chinese banyan, and silk oak (Char 2000a).

4. Waiawī scrub

Waiawī is a solitary, large shrub to small tree. This yellow-fruited variety of strawberry guava is common on the upper mauka slopes facing south Hālawa Valley. Waiawī scrub is open, often sharing some of the same components found in the adjoining mixed grass/shrub vegetation type. Christmas berry shrubs are common to occasional throughout this vegetation and koa haole and silk trees are more numerous along the lower boundaries of this vegetation type (Char 2000a).

5. Ruderal vegetation

Ruderal or weedy roadside vegetation occurs along the paved and unpaved roads throughout the Red Hill Fuel Storage Area. This vegetation type is periodically maintained in many places and occurs as a narrow band (3 to 6 ft [1 to 2 m]). It consists largely of annual herbaceous species and various grasses including Bermuda grass (*Cynodon dactylon*), Guinea grass, Indian dropseed (*Sporobolus diander*), and lovegrass (*Eragrostis amabilis*). Creeping indigo (*Indigofera spicata*), *Heliotropium procumbens* var. *depressum*, and *Sida ciliaris* are three perennial herbs that form large, low mats along the roadside. There are also a number of weedy annuals that are seasonal and occur in larger numbers during the wetter months (chickweed [*Cerastium fontanum*], Australian brass buttons [*Cotula australis*], and artillery plant [*Pilea microphylla*]) (Char 2000a).

6. Lowland mesic shrubland

The lowland mesic shrubland was observed along the ridgeline trail above the watertower, going mauka towards the electrical tower, at a higher elevation than the mixed grassland/shrub. In this area, the vegetation quickly became predominantly native forest with an ʻōhiʻa (*Meterosideros polymorpha*) and koa overstory, and ʻaʻaliʻi, sandalwood (*Santalatum freycinetianum*), alaheʻe (*Canthium odroratum*), ʻākia, and pūkiawe (*Styphelia tameiameiae*) as the dominant mid canopy species. The ground cover in this area contained large thickets of ʻūlei, among several species of non-native grass. There was an abundance of huehue.

3.3.5.5 Waiawa Watershed

Botanical surveys were conducted at Waiawa Watershed in 2000 (Char 2000b) and in 2006 (NAVFAC PAC 2006j). None of the plants surveyed at the Waiawa Watershed is a federally- or SOH-listed threatened or endangered species or a species of concern. No sensitive, native plant-dominated communities exist at the site. There are six major vegetation types recognized at the Waiawa Watershed, all of which are dominated by introduced or alien species: (1) low-statured koa haole scrub; (2) tall-statured koa haole scrub; (3) Java plum forest; (4) Guinea grasslands; (5) savanna grass; and (6) ruderal vegetation. Of the 162 plant species inventoried at the site, 148 (91.4 percent) are introduced; three (1.8 percent) are originally of Polynesian introduction; and 11 (6.8 percent) are native (Char 2000b). All six vegetation types are dominated by alien plant species.

1. Low-statured koa haole scrub

The low-statured koa haole scrub vegetation type can be found on the steep valley walls. It consists of an open-canopied, low-statured koa haole scrub, 3 to 10 ft (1 to 3 m) tall. There are a few Java plum, kiawe, ʻopiuma, and Chinese banyan trees found on the steep walls. Between the woody elements on the west wall is a somewhat dense cover of Guinea grass. Guinea grass and sourgrass (*Digitaria insularis*) form patches more often on the east wall. Plants of *Portulaca pilosa*, maile hohono (*Ageratum conyzoides*), pigweed (*Portulaca oleracea*), ʻuhaloa, and cliffdrake fern (*Pellaea viridis*) are locally common and form good-sized patches on the rock outcrops. Other plants found on the rock outcrops include periwinkle (*Catharanthus roseus*), natal redtop grass, lantana, klu (*Acacia farnesiana*), Chinese violet, comb hyptis (*Hyptis pectinata*), and coat buttons. Five native species were also observed in this area: (1) pili grass (*Heteropogon contortus*), ʻaʻaliʻi, pōpolo, ʻala ʻala wai nui (*Peperomia leptostachya*), and ʻuhaloa (Char 2000b).

2. Tall-statured koa haole scrub

This vegetation type is 12 to 20 ft (4 to 6 m) high and is found on the valley floor in areas with deeper soil and in some places at the base of the steep gulch walls. Guinea grass forms a very dense cover, up to 8 ft (2.5 m) tall, between the shrubs (Char 2000b). NAVFAC PAC biologists described the Guinea grass groundcover as virtually impenetrable.

3. Java plum/mixed forest

This vegetation type covers approximately 23 ac (9.2 ha) of the site and is found on the valley floor bordering the streams. Java plum is the most abundant tree species and occurs in areas closer to the stream banks. The mid and understory were sparse, as is typical of this type of forest. No native species were observed along the stream. Smaller numbers of scattered individual trees or small tree stands include macaranga (*Macarang tanarius*), albizia (*Paraserianthes falcataria*), mango (*Mangifera indica*), octopus tree, African tulip (*Spathodea campanulata*), monkeypod, and Chinese banyan. Tree heights vary from 40 to 60 ft (12 to 18 m) and the canopy is closed (Char 2000b).

The understory is deeply shaded and supports tree saplings as well as shrubs of guava (*Psidium guajava*) and koa haole. Groundcover is patchy and consists of seedlings of woody components and more shade-tolerant species such as bucketgrass (*Oplismenus hirtellus*), coral berry, belchnum fern (*Blechnum occidentale*), and hairy sword-fern (*Nephrolepis multiflora*). There are also a number of ornamental or landscape plantings that have escaped cultivation from the nearby subdivision and have established populations in the Java plum/mixed forest areas. These include asparagus fern (*Asparagus setaceus*), rabbit's foot fern (*Davallia feejeensis*), allspice (*Pimenta dioca*), Mickey Mouse plant (*Ochna thomasiana*), mock orange (*Murraya paniculata*), Victorian box (*Pittosporum undulatum*), and fern tree (*Filicuium decipiens*) (Char 2000b).

4. Guinea Grass Grassland

This vegetation type covers approximately 3 ac (1.2 ha) of the site and is found on the valley floor along the paved road. Guinea grass forms robust clumps, 4 to 6 ft (1 to 2 m) tall, with grass cover between 90 to 95 percent. A few koa haole shrubs are scattered through the grassland, primarily on the margin where it interfaces with koa haole scrub vegetation type. A number of weedy species can be found in recently disturbed areas (soil mounds): (1) fuzzy rattlepod (*Crotalaria incana*), spiny amaranth (*Amaranthus spinosus*), *Trianthema portulacastrum*, castor bean (*Ricinus communis*), Spanish needle (*Bidens pilosa*), Jimson weed (*Datura stramoniom*), and lion's ear. Native plant species observed in the disturbed areas (soil mounds) include pā'ū o Hi'aka, 'ilima, 'uhaloa, and kukaepua'a (*Digitaria setigera*) (Char 2000b).

5. Savanna

This vegetation type covers about 5 ac (2 ha) on the east slopes below the Pacific Palisades subdivision. It consists of scattered individuals and small clumps of trees and shrubs (5 to 20 percent cover) in a dense mix of Guinea grass, although sourgrass may be present in places. Koa haole, guava, Christmas berry, silk oak, and Java plum are the most common woody components. Natal redtop grass, pluchea (*Pluchea carolinensis*), lantana, indigo (*Indigofera suffruticosa*), virgate mimosa (*Desmanthus pernambucanus*), and swollen fingergrass are present in patches where Guinea grass is sparse (Char 2000b).

6. Ruderal Vegetation

The ruderal or roadside vegetation occurs as a narrow band along the paved and unpaved roads on the undeveloped areas. The species composition of the ruderal vegetation is different on either side of the road. Scrub forest with macaranga and Victorian box understory are on the stream side and Guinea grass leads upslope on the cliff side (NAVFAC PAC 2006j). A number of weedy species associated with this vegetation type are either confined to or are much more abundant here. They are composed of several grass species and weedy, mostly annual, herbaceous species with no one species dominating. The grasses include Guinea grass, pitted beardgrass, swollen fingergrass, Hilo grass (*Paspalum conjugatum*), Bermuda grass, and wire grass (*Eleusine indica*). Herbaceous species include several of the spurges (*Chamaesyce* spp.), nodeweed (*Synedrella nodeflora*), coat buttons, partridge pea, creeping indigo, and comb hyptis (Char 2000b).

3.3.5.6 NAVMAG PH West Loch Branch/Waipi'o Peninsula

Except for limited coastal marshlands, the vegetation at NAVMAG PH West Loch Branch/Waipi'o Peninsula is typically xeric (plants adapted to extremely dry habitat). Vegetated areas at the installation include: (1) improved areas; (2) unimproved and uncultivated areas; and (3) agricultural outlease areas (Figure 3-26) (DON 2001b). With the exception of some outlplanting of some ESA-protected species at the USFWS-controlled Honouliuli Unit of the PHNWR (Section 3.3.1.2), there are no federally- and/or SOH-listed threatened and/or endangered plant species or plant species of concern at NAVMAG PH West Loch Branch/Waipi'o Peninsula.

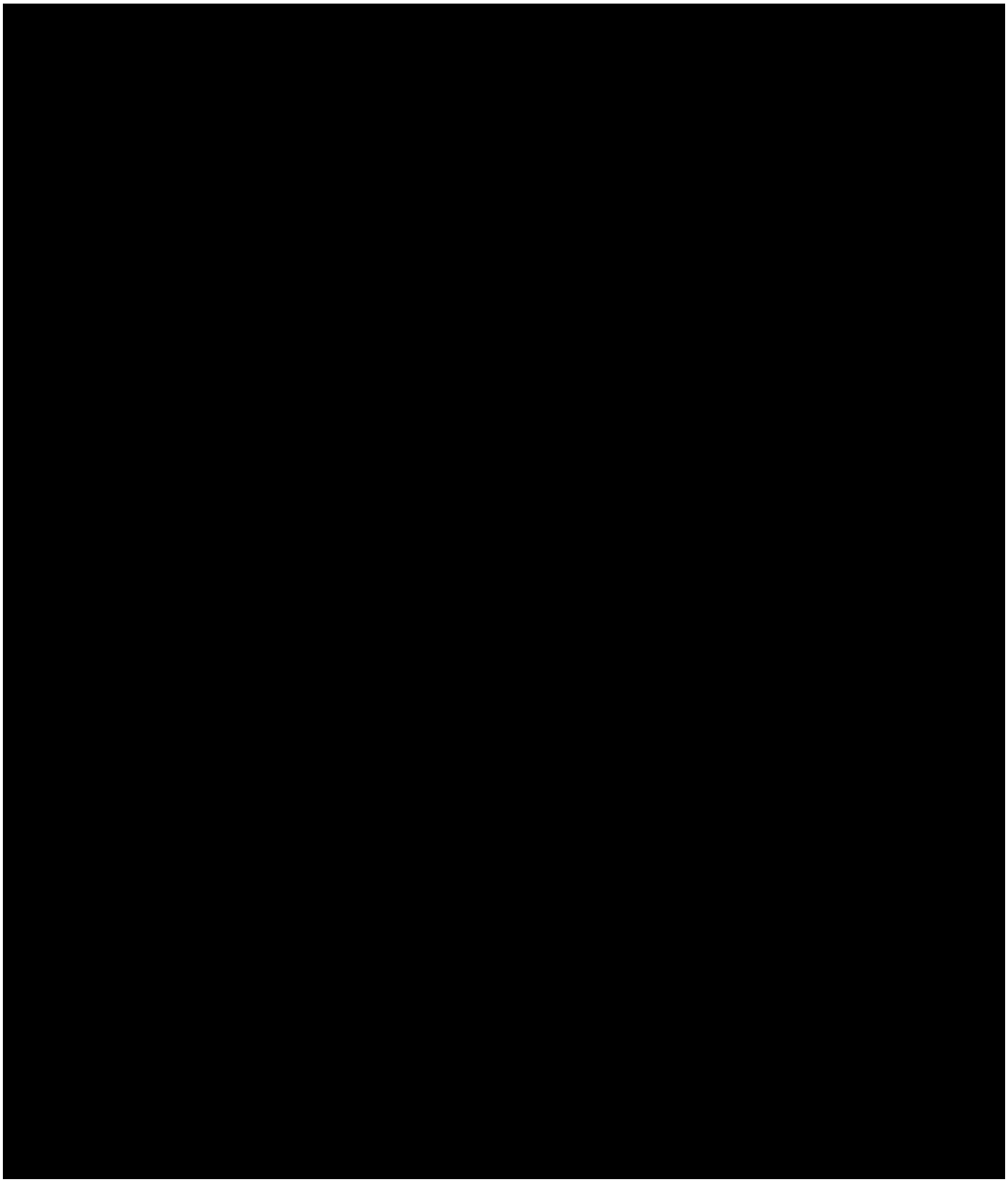
1. Improved Areas

A predominant tree canopy exists within the former West Loch housing area. There are informal tree plantings around the administration and shop buildings, but the wharf areas remain largely devoid of vegetation due to the clearing activities on the east side of the installation (DON 2001b).

2. Unimproved and Uncultivated Areas

West Loch. The predominant vegetation types on the unimproved and uncultivated areas are the kiawe forests, which cover roughly 287 ac (116 ha), and kiawe/koa haole, which cover about 223.5 ac (90.4 ha). Ground cover under these forested areas is primarily composed of panic grasses (*Panicum sp*.) and the semi-vining Chinese violet. Koa haole scrub covers approximately 148.2 ac (60 ha) (Figure 3-26) (DON 2001b).

Grassland dominated by panic grass (*Panicum virgatum*) also occupies a large portion of the station (152.7 ac +/- [61.8 ha]), particularly along the roadways and around the magazine storage areas. Other commonly observed grasses include buffelgrass, hurricane grass (*Dicanthium pertusum*), and natal redtop (DON 2001b).



Redaction:Defense Critical Security Information Statute 10 U.S.C. § 130e

Figure 3-26: Vegetation, NAVMAG PH West Loch Branch, JBPHH

3.4 CURRENT MANAGEMENT

This section describes the current management at PHNC in the following categories: (1) project-specific management actions; (2) natural resources studies; (3) use of GIS systems; (4) forestry; (5) community outreach; (6) outdoor recreation; (7) land management; (8) flood plains; (9) law enforcement; (10) wildland fire; and (11) leases and encroachment.

3.4.1 Protected-Species and Ecosystem Monitoring and Management

3.4.1.1 Protected Species Monitoring and Management

The following Navy programs are currently in place at PHNC in an effort to conserve, protect, and provide benefit to Hawaiian waterbirds (Hawaiian stilt, Hawaiian duck, Hawaiian coot, Hawaiian moorhen), white tern, Hawaiian short-eared owl, MBTA-protected birds, Hawaiian monk seals, and sea turtles.

1. Hawaiian Waterbirds

Pearl Harbor and its shoreline provide habitat for four federally-list endangered waterbird species (common moorhen, Hawaiian duck, Hawaiian black-necked stilt, and Hawaiian coot. The Navy has a variety of management actions in place to protect Hawaiian waterbirds and to enhance their habitat. They include:

- **Resource Agency Coordination.** The JBPHH IEP, NAVFAC PAC Natural Resource staff, and the NAVFAC HI Natural Resource Program Manager coordinate with federal and SOH agencies on natural resources issues pertaining to protected Hawaiian waterbirds. Resource agency consultation letters pertaining to the 2001 INRMP and other recent CNRH projects are presented in Appendix H.
- **Cooperative Agreements.** The Navy continues to comply with the terms of the Cooperative Agreement between the Navy, USFWS, NOAA Fisheries, and DLNR for the Protection, Development and Management of Fish and Wildlife Resources at JBPHH. Navy has an agreement for an overlay refuge at Pearl Harbor (Appendix I13).
- **Standard Operating Procedures.** CNRH has updated its SOP with regard to injured bird response (Appendix I2). The SOP instructs Navy personnel in how to respond to situations involving ESA-protected waterbirds.
- **Project Reviews and Consultations.** The Navy conducts project reviews and, as appropriate, conducts consultation with resource agencies to ensure minimal impact to protected species, including Hawaiian waterbirds.
- **Bird Surveys and Monitoring.** NAVFAC PAC completed bird surveys for PHNC (Appendix A8; NAVFAC PAC 2006a). The survey updated the information collected in preparation for the 2001 INRMP (Bruner 1999 and 2000). The survey assists NAVFAC PAC Natural Resource staff in their continued efforts to protect and conserve ESA-protected species at PHNC. The surveys report recommended that annual bird surveys occur at discrete or defined areas throughout the Pearl Harbor area. Furthermore, these survey areas should be established where access is relatively easy. In addition, the survey noted that Hawaiian stilts have nested at the non-operational sewage treatment plant at Pearl City Peninsula. The survey

recommended that this area should be monitored or surveyed during nesting season. The Navy monitors Hawaiian waterbird populations at core wetland areas (Honouliuli refuge unit) through the SOH's biannual waterbird survey.

- **Habitat Restoration.** In 2008-2009, the Navy removed approximately 60 acres of mangrove from the shoreline of Pearl Harbor. The removal action improved waterbird habitat within the harbor. A program to remove mangroves to restore waterbird habitat is described in Section 9.4.
- **Inreach and Community Outreach.** The Navy continues to promote awareness of ESA-protected and other protected species among Navy personnel and the community through ongoing educational efforts (e.g. Earth Day, bulletins), community service programs, and brochures, including information in the "Welcome Aboard" packet received by new personnel and base residents (Appendix I10).
- **Mitigation Measures During Training.** The Navy continues to prohibit bivouacking within 3,280 ft (1,000 m) of posted signs marking the presence of rare and/or protected plant and animal species or restoration projects. No training units larger than 30 personnel (platoon size) are allowed to bivouac outside of reusable bivouac sites provided with portable or reusable latrines. No open fires, burying or leaving of trash, food preparation, cutting, or clearing of vegetation, or disturbing of vegetation including mosses, grasses, shrubs, bushes, and trees are allowed during bivouacking. The Navy continues to prohibit training in areas marked by signs or fences indicating the presence of rare and/or protected species.

2. White Terns

Pearl Harbor and its shoreline provide habitat for the SOH-listed endangered seabird white fairy-tern. The Navy has a variety of management actions in place to protect white terns and to enhance their habitat. They are the same as many of the management actions described for Hawaiian birds including: (1) resource agency coordination; (2) cooperative agreements; (3) SOPs; (4) project reviews and consultations; (5) bird surveys; (6) inreach and community outreach; and (7) mitigation measures during training.

3. Hawaiian Short-eared Owls

Pearl Harbor and its shoreline provide habitat for the SOH-listed endangered owl (Hawaiian short-eared owl) (Section 3.3.1.1). The Navy has a variety of management actions in place to protect Hawaiian short-eared owls. They are the same as many of the management actions described for Hawaiian birds including: (1) resource agency coordination; (2) cooperative agreements; (3) SOPs; (4) project reviews and consultations; (5) bird surveys; (6) inreach and community outreach; and (7) mitigation measures during training.

4. MBTA-protected Bird Species

As discussed in Section 3.3.4.1, bird surveys have been conducted at PHNC and outlying areas in 2000 and in 2006. There are 49 MBTA-protected bird species at PHNC. Many of the MBTA-protected bird species are located at the PHNWR Honouliuli and Waiawa Units. Under the MBTA and EO 13186 (Appendix F1), the Navy cannot "take" migratory birds except for military readiness activities. If the Navy does take MBTA-protected bird species during military readiness activities, the Navy may be required to conduct monitoring and mitigative actions.

As discussed in Section 3.4.1.6, the Navy has removed approximately 60 ac (24 ha) of mangrove from the shoreline of Pearl Harbor and has supported the removal of mangrove at PHNWR Waiawa Unit and the reestablishment of native species there. The removal of the mangrove and the restoration of native wetland species helps conserve and sustain the MBTA-protected shorebirds that frequent Pearl Harbor. The Navy intends to remove mangrove from additional shoreline acreage (Section 9.4).

5. Hawaiian Monk Seals

Hawaiian monk seals are provided protection from harassment and disturbance within many areas of the PHNC by exclusion of the public. The Navy has provided NOAA Fisheries input regarding the presence of Hawaiian monk seals on the beaches at PHNC through routine coordination and communication between Navy environmental staff and agency personnel (DON 2001a, 2008a, 2008c; NOAA Fisheries 2008, 2009a, 2009b).

As described in the December 2008 *Final Programmatic Biological Opinion on U.S. Navy Activities in the Hawaii Range Complex 2008-2013* (NOAA Fisheries 2008) and the *Hawaii Range Complex Final Environmental Impact Statement (FEIS)/Overseas Environmental Impact Statement (OEIS)* (DON 2008a), mitigation measures are instituted to assure minimal impacts from training activities to marine mammals, including Hawaiian monk seals. These mitigation measures are detailed in the MMPA Letter of Authorization for the Hawaii Range Complex (NOAA 2009a and b) and the *Hawaii Range Complex FEIS/OEIS* (DON 2008a). These measures include:

- **Personnel Training and Implementation of SOPs**. Training of personnel and implementation of activity- specific SOPS are designed to minimize and/or avoid interactions with protected resources including marine mammals and sea turtles (DON 2008a). Navy Training and Operations staff adhere to Navy policies regarding education, inspections of training areas, and other protections at PHNC and nearshore training areas (Figure 2-2) pertaining to marine mammals (including Hawaiian monk seals) and other protected species.

- **Inspections of Training Areas**. Prior to any training activities, training areas are inspected for the presence of marine mammals (including Hawaiian monk seals). If marine mammals are observed during these inspections, training activities are delayed until the marine mammals voluntarily leave the area. If a Hawaiian monk seal is observed in Pearl Harbor, in nearshore training areas (Figure 2-2), or on property actively used by the Navy, the animal is reported to the Port Operations Tower which controls vessel traffic. All vessels are advised of the sighting, advised that the animal is a highly endangered species, and all vessels are cautioned to stay clear. The Tower also reports to CNRH environmental for data collection purposes or if there are any issues with the animals.

  All individual training events that involve underwater detonations use explosive charges no greater than 20 pounds (9 kilograms). Only sandy areas that avoid and/or minimize potential impact on coral are used for explosive charges on the shallow water floor (less than 40 ft [12 m]). Prior to detonation, the Navy requires that the area be determined to be free of marine mammals and sea turtles. The training event does not proceed if marine mammals or sea turtles are in the vicinity of the training event. The Navy continues to require that the area involved in underwater detonations (during training) be searched for injured animals after the detonation activities are complete.

> The Navy continues to require that established procedures are followed during amphibious crew inserts. These include having designated look outs watching for other vessels, obstructions to navigation, marine mammals including whales, Hawaiian monk seals, and sea turtles. Training coordinators are required to review training overlays that identify the insertion points and any nearby restricted areas. All sensitive biological receptors are avoided during training exercises.

In addition to the mitigation measures listed above, the Navy has developed a monitoring plan, *Hawaii Range Complex Monitoring Plan* (HRCMP) (DON 2008c), to provide marine mammal and sea turtle monitoring. The monitoring plan outlines the necessary monitoring and reporting the Navy must perform to comply with the terms and conditions of the NOAA Fisheries Biological Opinion and requirements of the *MMPA Letter of Authorization for the Hawaii Range Complex* (NOAA 2009a and b). The HRCMP was designed as a collection of focused studies pertaining to marine mammals and sea turtles and the use of mid-frequency sonar and explosives during Hawaii Range Complex training activities. Studies 1, 3, and 4 pertain to exposure and behavioral responses of marine mammals and sea turtles to Navy training activities. These studies include aerial surveys, marine mammal observers on board Navy ships, tagging of marine mammals and sea turtles, and shore based surveys. Study 2 investigates the geographic redistribution of marine mammals and sea turtles. This study employs aerial surveys before and after training events and the use of passive acoustics. Study 5 investigates the effectiveness of mitigative measures outlined in the Hawaii Range Complex EIS and the Biological Opinion. This study includes marine mammal observer/lookout comparisons and aerial surveys. Hawaiian monk seals are one of the focus species in the HRCMP. COMPACFLT will be collaborating with NOAA Fisheries on plans to gather additional data on the distribution, movement, and behavior of monk seals. Data collection/analysis and inter-agency cooperation will provide a net conservation benefit to the species and will inform mitigation plans which can be tailored more precisely to minimize interactions, whenever possible.

A Fisheries Species Recovery Plan (NOAA Fisheries 2007) has documented the continued sharp decline in the number of Hawaiian monk seals to approximately 1,200 individuals in the NWHI and MHI. In the MHI, the plan specified a goal to:

> "Ensure the continued natural growth of the Hawaiian monk seal in the MHI by reducing threats including interactions with recreational fisheries, disturbance of mother-pup pairs, disturbance of hauled out seals, and exposure to human and domestic animal diseases. This should be accomplished with coordination of all federal, state, local and non-government parties, volunteer networks, and increased outreach and education in order to develop a culture of co-existence between humans and seals in the MHI."

The Navy has provided NOAA Fisheries input regarding the presence of Hawaiian monk seals on PHNC beaches through routine coordination and communication between JBPHH staff and agency personnel (DON 1998, 2001a, 2008a, 2008c; NOAA Fisheries 2008, 2009a, 2009b). Current management for the species at PHNC is guided by this document and, in part, by the December 2008 *Final Programmatic Biological Opinion on U.S. Navy Activities in the Hawaii Range Complex 2008-2013* (NOAA Fisheries 2008). The *Hawaii Range Complex FEIS/OEIS* (DON 2008a) did not identify specific threats to Hawaiian monk seals from activities associated with the Navy's activities in the Hawaii Range Complex. Mitigation measures identified in Section 6.1 of the Hawaii Range Complex FEIS/OEIS would mitigate the effects of training exercises at PHNC. The following Navy programs are currently in place at PHNC, including nearshore training areas (Figure 2-2), in an effort to conserve, protect, and provide benefit to

Hawaiian monk seals to ensure their long-term conservation, consistent with the Species Recovery Plan.

Food limitation: In the NWHI, food limitation is a crucial threat to the recovery of Hawaiian monk seals but that is not the case for the MHI or PHNC, in particular. Due to security requirements, the nearshore environment at PHNC (including NDSA and off shore training areas – Figure 2-2) has access and shore fishing restrictions. Fishing pressure at PHNC is likely to be less than other nearshore environments on O'ahu, the majority of which do not have fishing restrictions. Although monk seals forage primarily in deeper water, PHNC may provide a source for regional fishery enhancement. Shore fishing at PHNC will continue to be limited in the foreseeable future.

Marine Debris Entanglement at Sea: Marine debris entanglement is a crucial threat to Hawaiian monk seals. The Navy regularly removes marine debris from Pearl Harbor and PHEC. As part of Hawaii Range Complex activities, expended training materials do enter the ocean. When possible, these materials are retrieved. Expended training materials that cannot be retrieved settle to the ocean bottom and are covered by sediment deposition over time (DON 2008a). These activities provide a benefit to and aid the recovery of the species.

In accordance with the Marine Debris Research, Prevention and Reduction Act (PL 104-449, 22 DEC 2006) and the Marine Plastic Pollution Research and Control Act (33 U.S.C. Section 1914), the Navy participates as a member of a federal Interagency Marine Debris Coordinating Committee which includes NOAA, USEPA, the Marine Mammal Commission and others. The committee is responsible for developing and recommending approaches to reduce the sources and impacts of marine debris. In addition, the Navy has assisted NOAA Fisheries and DOFAW biologists in two monk seal rescue operations in west Kaua'I (one event involved a seal with a fishing hook embedded in its mouth and another event with a seal that had debris entangled around its neck and abdomen).

Consistent with the Navy mission and conforming to Navy policy to reduce and prevent adverse impacts on the environment through the environmental planning process, the Navy consistently seeks ways to reduce the amount of waste generated by its afloat forces. This is done, in part, by choosing items with less packaging and consistently improving the manner in which waste is handled. Many Navy ships exceed legal requirements regarding waste management. For example, many ships have plastic waste processors aboard to consolidate, melt and store plastics into large discs. Those discs are then retained on board until they can be transferred to shore for potential reuse or disposal.

In addition to exercising strict discipline and accountability regarding the Navy's environmental protection obligations, the Navy promotes excellence in environmental protection through its Secretary of the Navy environmental awards program. For example, the USS PAUL HAMILTON, home-ported at Pearl Harbor, received a Secretary of the Navy award in 2009 for its environmental protection program which included holding all of its plastics, metal and glass aboard the ship until all could be transferred to a port. While in port, the ship's crew participated in a number of O'ahu beach cleanups.

In Hawai'i, the Navy has participated for more than a decade with the University of Hawai'i Sea Grant Extension program's Interagency Task Force and the Ocean Conservancy's International Coastal Cleanups to raise awareness and facilitate mitigation of marine debris. When mission priorities allow and when determined to be of training value, Navy members have worked in partnership with other agencies in removing derelict fishing gear caught on the ocean floor in the NWHI. Navy members and those employed by or affiliated with the Navy often organize and

participate in community shoreline cleanups, using those opportunities to educate and bring attention to the issue. Marine debris is frequently a topic of a display at the annual Navy Region Hawai'i Earth Day Fair with its focus on children and education regarding protection of the environment. When participating in local educational fairs and gatherings, the displayed materials include a photo presentation on the impacts of marine debris on marine species, including seabirds, which inadvertently consume plastics and perish as a consequence.

These Navy programs, policies, and activities serve to minimize marine debris associated with Navy activities and provide a benefit to and aid the recovery of Hawaiian monk seals.

Disease: Introduction of disease is a serious threat to Hawaiian monk seals as they may lack the antibody to fight the disease. With a small population, the introduction of lethal disease could devastate the recovery of the species. In the MHI, concern lies with the introduction of infectious disease via transmission from livestock, feral animals, pets, or humans.

Many shoreline areas of PHNC are industrialized and, consequently, are not frequented by domesticated animals such as dogs or cats; however, feral cats have been observed at Iroquois Point and near Honouliuli Wildlife Refuge. To address this problem, the Navy has provided funding, as part of the JBPHH environmental program, to USDA APHIS Wildlife Services for nuisance animal/predator control (primarily trapping and removal of feral cats) on Iroquois Point Beaches and in areas near the Honouliuli Wildlife Refuge.

There are residential shoreline areas at PHNC (Pearl City Peninsula, Ford Island, Hospital Point) and Iroquois Point. Residents at PHNC and Iroquois Point are allowed to keep cats and dogs as pets as long as the animals are restricted to the family housing areas. These animals are not allowed on the beaches at PHNC. Leash laws for residents are enforced by security patrols. These restrictions likely reduce the possibility of introduction of certain diseases to Hawaiian monk seals at PHNC. These restrictions provide a benefit to and aid the recovery of the species.

Loss of Terrestrial Habitat: Loss of terrestrial habitat as a result of such factors as storms and sea level rise is a serious threat to Hawaiian monk seals in the NWHI. Global warming is an accepted scientific observation and is believed to bring about an increase in the global sea level as a result of melting polar ice caps and thermal expansion of seawater due to surface warming. The rate of sea level rise is expected to be greater than that of normal sea level fluctuations resulting from normal (non-anthropogenic) processes. Due to global warming, sea level is expected to rise as much as 3 ft (1 m) by the end of the 21st century (University of Hawai'i School of Ocean, Earth Science, and Technology 2009). PHNC is sited on 5,437 ac (2,005 ha) located at elevations ranging from sea level to 80 ft (24 m) above mean sea level. The shoreline areas are very flat and low-lying with a nominal elevation of about 15 ft (4.6 m) above mean sea level. The built environment at PHNC is generally at elevations greater than 10 ft (3 m) and away from the shoreline.

As described in Section 3.1.1.5, large portions of the PHNC have been altered by human activity. Still, large portions of the coastline are undeveloped and are overgrown by mangrove and are not considered desirable habitat for Hawaiian monk seals. With the notable exception of a Hawaiian monk seal hauled out at Marine Railway No. 2 at the Shipyard, the majority of the seal haul outs at PHNC have been at the Iroquois Point-Pu'uloa Beach area. Iroquois Point-Pu'uloa Beach is leased to a company for management of the housing and beach areas. Currently, the management company notifies the O'ahu Hawaiian Monk Seal Volunteer Network when a monk seal hauls out on the beach; these volunteers prevent human disturbance of the seals and provide educational information.

In general, the majority of the PHNC shoreline would remain relatively unattractive as terrestrial habitat for Hawaiian monk seals due to the lack of preferred sandy beach. The combination of access restrictions over much of PHNC, and minimization of interactions with Hawaiian monk seals through signage, cordoning of haul out areas, and security patrols, provide relatively undisturbed terrestrial habitat.

Fishery Interaction: Within the MHI, fishery interaction with Hawaiian monk seals is a serious threat to the species. As discussed in Section 3.4.6, fishing is permitted in only five authorized areas at Pearl Harbor and Iroquois Point (Figure 3-22). These restrictions reduce the risk of hooking/entanglements related to pole fishing. The Navy limits fishing at Pearl Harbor to catch-and-release, shore fishing within five designated areas. These five designated areas are open to fishing seven days a week, 24 hours a day. Two of the designated fishing areas are open to the general public (Areas 2 and 3, Pearl City Peninsula, East Loch, and Aiea Shoreline). Two of the designated fishing areas are open only to the housing area residents and their guests (Area 1, Ford Island; Area 5, Hospital Point). Area 4 (Ford Island Bridge and northeast Ford Island) is open to DOD Card Holders only. Iroquois Point Club and Resort allows fishing in authorized fishing areas at Iroquois Point/ Pu'uloa (Figure 3-22); however, anecdotal information indicates that fishing occurs outside of the authorized fishing areas at Iroquois Point. The Navy fishing restrictions allow only for catch-and-release pole fishing from the shore. Fishing from privately-owned boats is prohibited within Pearl Harbor. Commanding Officers of ships moored in Pearl Harbor but outside of the Shipyard may authorize crewmembers to fish from their own ship's decks. Fishing is prohibited within the NDSA and the Barbers Point Underwater Range (Figure 2-2).

While there is some potential for interaction, the frequency and locations of Hawaiian monk seal haul-out areas recorded over the past five years suggests a preference for Iroquois Point-Pu'uloa Beach whereas the vast majority of fishing opportunities - both temporal and spatial - are along the lagoon side of Iroquois Point (away from the sandy beach), Pearl City Peninsula, East Loch, Aiea Shoreline, Ford Island, and Hospital Point. Shoreline fishing and access restrictions are enforced by installation security details. These restrictions and controls reduce the number of fishing interactions the Hawaiian monk seals endure and, therefore, provide a benefit to and aid the recovery of the species.

Human Interaction: Human interaction is a serious threat to Hawaiian monk seals in the MHI. At PHNC, there is the potential for disturbance of Hawaiian monk seals (human interaction) through shoreline access and fishing activities. As a result of security requirements, access to much of the shoreline is limited to DOD card holders, residents, and guests (Figure 3-22). However, public access is limited and controlled at PHNC and, as a result, limits human interaction with the seals. Mitigative measures for each of these activities include:

- **Security Restrictions.** As a result of security requirements, access to much of the shoreline, except at Iroquois Point, is limited to DOD card holders, residents, and guests (Figure 3-22). Installation security enforces shoreline restrictions at PHNC. The Navy also controls access to the NDSA and the Barbers Point Underwater Range (Figure 2-2).

- **Iroquois Point Access Restrictions.** The locations of the majority of the observations of Hawaiian monk seals at PHNC are at Iroquois Point-Pu'uloa Beach, Navy-owned land that is managed, under a long-term lease by a private entity. Access to the Iroquois Point-Pu'uloa Beach residential community is controlled by a private entity and public access to the beach is restricted to the hours of sunrise to sunset. Private security enforces beach restrictions at Iroquois Point

- **Monitoring.** The Navy will expand Wildlife Services' contract in fiscal year 2012 to include monitoring and collecting data on monk seals at Iroquois Point. Currently, the beaches along Iroquois Point are checked daily for monk seals by NOAA volunteers with the Oahu Monk Seal Response Team, a volunteer group that assists NOAA's Pacific Island Regional Office (PIRO) and Pacific Islands Fisheries Science Center (PIFSC) in monk seal response issues. The response team identifies and records information on seals that haul out on Kalaeloa beaches, sets up a protection zone to guard them from disturbance while they are resting, and provides public onlookers with information about the Hawaiian monk seal and its endangered status. Additionally, the team monitors pupping events and reports animals in distress (due to hooking, entanglement or otherwise) and will stand by in such instances until help arrives.

  The Navy will coordinate with NOAA and volunteers with the Oahu Monk Seal Response Team to ensure that seal monitoring and data collection by Wildlife Services complements the volunteer monk seal monitoring program that is currently in place. Coordination will include working with NOAA to determine the types of data that should be collected and arranging for Wildlife Services to receive the appropriate training to collect monk seal data.

  The NAVFAC HI Natural Resources Program Manager maintains a log book of all sightings of Hawaiian monk seals at PHNC (Appendix A13). The Navy has SOPs related to Hawaiian monk seal haul outs (Appendix I3) and marine mammal stranding response plan (Appendix I5).

- **Promote Awareness.** The Navy continues to promote awareness of Hawaiian monk seals among Navy personnel, dependents, and guests through on-going educational efforts, community service, and brochures.

- **Base Planning.** PHNC staff follow a routine procedure to assure coordination among facilities planners, resource managers, and government agencies to provide relevant information on issues with potential to affect protected species, including Hawaiian monk seals.

- **Law Enforcement.** PHNC military, civilian, and contractor security forces work with CNRH Natural Resources Manager in reporting any incidents observed pertaining to Hawaiian monk seals on the beach, enforce beach and fishing restrictions, and ensure that the public does not disturb monk seals hauled out on the beach. The federal law enforcement office has one officer designated as a JBPHH Game Warden. This officer responds to reports of criminal activity at Iroquois Point and enforces laws which protect the seals.

Biotoxins: Biotoxins are a moderate threat to Hawaiian monk seals; however, they have not been identified as a threat at PHNC. JBPHH has an NPDES permit from SOH Clean Water Branch for all storm drains entering Pearl Harbor and other shoreline areas under Navy jurisdiction. This permit requires JBPHH to maintain and implement a Stormwater Pollution Prevention and Control Plan which includes scheduled sampling for contaminants in water exiting storm drains and outlines best management practices for reducing contaminants entering the marine environment. The Navy monitors storm water discharges, including nutrient concentrations, from Navy lands into Pearl Harbor. Navy activities at PHNC are not likely to trigger biotoxin outbreaks in the marine environment.

Vessel Groundings: Vessel groundings are considered a moderate threat to Hawaiian monk seals. During the Navy's tenure, Navy vessels have grounded around the shallow entrance to Pearl Harbor; these incidents are few and far between. The Navy rigorously trains personnel to avoid grounding water craft. Any grounding incident is immediately and vigorously addressed. Every effort is made to avoid releases of fuel and oil and to promptly remove the vessel from the site. No fishing gear or hooks are aboard that could be lost and cause entrapment or entanglement of Hawaiian monk seals. The vessels are not permitted to remain at the site and deteriorate. Navy protocols reduce the potential for vessel groundings to occur and remove the potential for harm to Hawaiian monk seals from vessel groundings.

Contaminants: The presence of contaminants in Hawaiian monk seal habitat is a moderate threat to the species. Pearl Harbor receives runoff and pollutants from 22 percent of the land area of O'ahu including former and existing agricultural lands, urban areas, and commercial and light industrial areas. Pearl Harbor is on the USEPA's National Priorities List. The Navy has funded a sediment quality study in the harbor to identify problem areas. In addition to that study and other restoration programs, the Navy has in place environmental compliance programs at PHNC that address the proper handling, use, storage, and disposal of hazardous and regulated materials. These compliance and restoration programs reduce the potential for contaminants to enter the environment, including Hawaiian monk seal habitat, and/or harm the seals.

The Spill Prevention Control and Countermeasure (SPCC) Plan requires that natural resources are protected during a spill. Also, the Natural Resources Damage Assessment Plan, which is a separate document from the SPCC plan, is a new plan coming out shortly documenting natural resources baseline information and rapid response measures to protect natural resources in the event of a spill.

Summary: The coordination between Navy, NOAA, volunteer groups, and law enforcement and the overall plan for protecting Hawaiian monk seals at PHNC and Kalaeloa is an adaptive and evolving strategy. The effectiveness of the arrangement and interaction between all parties involved and the adequacy of the allocated funding is revisited each year as part of the annual JBPHH INRMP review. If current practices are ever deemed inadequate, then new solutions to protecting seals will be sought after and pursued.

5. Sea Turtles

Pearl Harbor provides habitat for sea turtles (green turtle, hawksbill turtle). The JBPHH IEP, NAVFAC PAC Natural Resource staff, and the NAVFAC HI Natural Resource Program Manager coordinate with federal and SOH agencies on natural resources issues pertaining to threatened and endangered species. The Navy coordinated with federal and SOH agencies in the preparation of the 2001 INRMP and is coordinating with them for this INRMP. Resource agency consultation letters pertaining to the 2001 INRMP and other recent CNRH projects are presented in Appendix H. The Navy continues to comply with the terms of the Cooperative Agreement between the Navy, USFWS, NOAA Fisheries, and DLNR for the Protection, Development and Management of Fish and Wildlife Resources at JBPHH.

CNRH has updated its SOPs with regard to stranded sea turtles (Appendix I3). This SOP instructs Navy personnel in how to respond to situations involving ESA-protected sea turtles. In an order to protect sea turtles from propeller strikes, JBPHH has installed prop guards on all small boats under NAVSTA's control (security and FRT vessels) and plans to configure prop guards for the water taxis that frequent the landings.

NAVFAC PAC completed fauna surveys of PHNC including a marine survey of Pearl Harbor and PHNC (Appendix B1; Smith *et al.* 2006). This survey updated the information collected in preparation for the 2001 INRMP (Dollar and Brock 2000). This survey assists NAVFAC PAC Natural Resource staff in their continued efforts to protect and conserve ESA-protected species at PHNC.

The Navy continues to promote awareness among Navy personnel of ESA-protected and other protected species through ongoing educational efforts, community service programs, and brochures included in the "Welcome Aboard" packet received by new personnel and base residents (Appendix I10).

3.4.1.2 Marine Debris Reduction

As discussed in Section 3.4.1.1, (Hawaiian monk seals), the Navy consistently seeks ways to reduce the amount of waste generated by its afloat forces. Many Navy ships not only meet existing legal requirements regarding waste management but exceed those requirements. The Navy does not dispose of plastics at sea. Instead, Navy ships retain all plastics on board, melting and compressing the accumulated materials into disks which are held on the ship until the ship reaches its next port for land-based recycling or disposal. At a workshop on marine debris at the Waikiki Aquarium, former Navy Region Hawaii Commander, Admiral John Townes, showed a sample consolidated plastic disk to workshop attendees (Photo 3-72). In addition, Navy members have worked in partnership with other agencies in removing derelict fishing gear caught on the ocean floor in NWHI. Also, Navy volunteers participate in beach cleanups on O'ahu and Kaua'i in a continuing effort to protect marine animals and as participants in the National Marine Debris Monitoring Program.

Photo 3-72: Admiral John Townes displaying a plastic disk created from a Navy afloat recycling program.

3.4.1.3 Access Restrictions

For the purposes of security, public safety, and the interests of the military mission, the Navy restricts access to the shoreline and waters of PHNC, including the NDSA (Figure 2-2).

1. Waiawa Wetland

The Waiawa Stream Aquatic Species Survey (NAVFAC PAC 2007c) recommended that the portion of Waiawa Stream that contains indigenous dragonfly and native fish species be retained in its natural state. Furthermore, the survey report recommended that no land development be pursued that would alter the quality of the stream or degrade the streamside habitat. The Navy continues to maintain the undeveloped nature of Waiawa Wetlands and limits public access to provide a benefit to bird, insect, and aquatic species.

3.4.1.4 Invasive Species

As defined by EO 13112, an invasive species is an alien (non native) species whose introduction does or is likely to cause economic or environmental harm or harm to human health. Invasive species management generally begins through prevention, and subsequently

addresses early detection and monitoring, and finally control and eradication. Financial costs increase as species become established and widespread, so it is of interest to prevent introductions as much as possible. Prevention includes ensuring clean gear and vessels during interport movements (biosecurity), and good outreach and education practices to discourage Navy personnel and the NEX from importing and/or propagating invasive species.

1. Biosecurity

OPNAV 5090.1C adopts the U.S. Coast Guard (USCG) guidelines for ballast water management as follows: If it is necessary for a surface ship to load ballast water in an area that is either potentially polluted (as defined in paragraph 22-10.2) or within 3 nautical miles (nm) (6 km) from the shore (e.g., amphibious ships operating in such waters and ballasting to operate landing craft or tankers ballasting to replace offloaded cargo), the ship shall pump the ballast water out when outside 12 nm (22 km) from shore and twice fill the tank(s) with clean sea water and pump prior to the next entry within 12 nm (22 km) from shore. Surface ships will affect a ballast exchange twice in clean water, even if ballast water was pumped out before exiting the polluted waters or 3 nm (6 km) limit, since residual water remaining in a tank after emptying it may still contain unwanted organisms, which could be transferred during the next ballasting evolution. During the planning stages of an exercise, environmental instructions are noted to ensure training participants are aware of this policy.

The Navy employs hull-husbandry procedures, as identified in Naval Ships' Technical Manual Chapter 081 Waterborne Underwater Hull Cleaning of Navy Ships, which reduce the accumulation of hull fouling organisms and the associated risk of aquatic invasive species introductions. Concerns about invasive species transport have been raised regarding decommissioned vessels, barges, platforms, or other objects stationary for long periods of time scheduled to arrive in Pearl Harbor. The Navy has managed these risks in prior situations by moving objects to fresh water to kill fouling organisms. Section 9.3 discusses a need to coordinate with CNO and CNIC on the development of appropriate management measures to further address the risk of spreading aquatic invasive species through this pathway. The Navy continues to raise awareness regarding the potential harm AIS can cause to Hawai'i's sensitive ecosystems.

Fuel compensation water, which is sea-water pumped into fuel tanks to compensate for loss in fuel ballast as fuel is consumed, is currently unregulated. "Comp" water was intended to be addressed by the Uniform National Discharge Standards (UNDS) 40 CFR 1700, issued by the USEPA with the Navy being the lead consulting agency, but has not as yet been addressed. A project to analyze the risk of comp water serving as a vector for introduced aquatic species needs to be undertaken and is recommended in Section 9.3. This project would be developed and implemented in close coordination between CNO and CNIC as it may contribute to Navy-wide processes.

The Navy continues to cooperate with DAR by providing early notification of decommissioned vessels, barges, platforms or other objects stationary for long periods of time that are scheduled to arrive in Hawai'i as well as implementation of management activities to reduce risk of aquatic invasive species (AIS) transfer. The Navy ensures that the cleaning of vessel hulls, ancillary gear and other surfaces in the water as well as ballast water flushing is budgeted for inactive vessels coming to Hawai'i. The Navy continues to partner with DAR in addressing AIS issues in Pearl Harbor by providing notification of AIS matters and jointly working on prevention, early detection monitoring, and eradication projects. DAR has the capacity to address such matters with specialized survey equipment including a remote operated vehicle, specialized removal equipment, well-trained divers, and the nation's only rapid-response team for AIS. The Navy

continues to raise awareness among active duty personnel, dependents, and civilian employees of the potential harm AIS can cause to Hawai'i's sensitive ecosystems. Furthermore, the Navy continues to employ preventative steps to minimize risk of introducing AIS.

The Navy requires decontamination (cleaning) of all vehicles, equipment, personal gear, shoes, and clothing before personnel may enter a training area at PHNC in order to minimize the introduction of invasive species.

Introduced organisms, such as the brown tree snake (*Boiga irregularis*), insects, rodents, or other organisms, can arrive via cargo and invade Hawaii. Currently, cargo from overseas is inspected by customs and border patrol agents with the assistance of USDA. However, inspections from mainland cargo may not occur. Section 9.3 recommends that a Pearl Harbor Instruction be generated to mandate and address a procedure for all cargo inspections and cargo-staff training and that training of cargo staff during loading/offloading procedures occur on a formal basis.

Potentially invasive plant species can also be spread through poor landscaping choices. Section 9.3 recommends that landscaping plans be reviewed by a NAVFAC HI biologist to ensure no invasive species are planted. Ornamental plants sold at the Navy Exchange also could potentially create invasive species problems. Section 9.3 recommends that NAVFAC HI Environmental work with NEX to limit plants being sold that are invasive. Landscaping with ornamental plants can be screened for invasiveness using Hawaii's weed risk assessment screening program, which scores a species' invasiveness based on a series of life-history and biological characteristics (Weed Risk Assessment for Hawai'i and Pacific Islands 2011).

2. Control and Eradication

Once established, introduced organisms can be difficult or impossible to eradicate unless ample funding is dedicated and coordination with outside agencies and the public are conducted. When eradication is not possible, control operations can continue to provide a level of protection for the native species and habitats threatened by the invasive species. Several invasive species require control at PHNC to protect sensitive species and habitats. These are: feral cats, mallards and mallard-Hawaiian duck hybrids, mangroves, pickleweed, kiawe, multiple vegetation species at Red Hill, and the alien algae *Gracilaria salicornia* (gorilla seaweed).

Feral cats, even those that are sterilized and fed in feral cat colonies, hunt and prey on multiple species of birds, including endangered waterbirds. A feral cat was recently photographed with an endangered Hawaiian coot in its mouth adjacent to the PHNWR Honouliuli Unit. Cat feeding stations have been set up by in many locations around Pearl Harbor, some on Navy land. Navy policy dictates that feral and stray cats are not to be fed (Department of Defense Initiative [DODI] 4715.3) on Navy lands. Section 9.3 recommends enforcement of this policy and control of feral cats in wetland areas as required.

The requirement to control mallards and mallard Hawaiian duck hybrids is described in Section 3.4.1.1. The requirement to control mangroves and pickleweed is described in Section 3.4.1.6. The requirement to control kiawe and other invasive coastal plant species at Waipi'o Peninsula and West loch, and a variety of invasive plant species at Red Hill, are described in Section 3.4.1.5. The requirement to control *Gracilaria salicornia* is described in Section 3.4.2.3.

3.4.1.5 Restoration of Natural Resource Areas

DODI 4715.3 directs DOD agencies to manage natural resources through principles of ecosystem management. Ecosystems with large proportions of native species are to be protected, and habitat restoration activities are to focus on these habitats. Areas with significant natural resource values, as shown in Table 3-1, are to be managed to conserve those values. As described in Section 3.4.1.6, the Navy has removed approximately 60 ac (24 ha) of mangrove (an invasive plant species) at PHNC, supported the removal of mangrove at PHNWR Waiawa Unit, and has supported the re-establishment of native vegetation in these areas. Protection and restoration of the existing native plant community at Red Hill Storage Area should be undertaken. A feasibility study, including a pilot field project, should investigate coastal vegetation restoration at Waipi'o Peninsula and West Loch through removal of invasive species and promotion of recolonization of native species through native seed-bank generation and/or outplanting.

3.4.1.6 Wetlands

Wetland goals and objectives are to restore wetland habitat while retaining wetland function. Wetland habitats, specifically for shorebirds and waterbirds, such as the endangered Hawaiian stilt, are to be restored through the removal of invasive mangroves and pickleweed. Approximately 60 ac (25 ha) of wetland have already been cleared of mangroves; however, 102 ac (41 ha) in Pearl Harbor remain. The cleared areas are experiencing mangrove regrowth and need to be maintained. Mangrove thickets in the brackish and marine waters around Pearl Harbor exclude waterbirds from their primary foraging location along the shorelines. Approximately 116 acres of wetland at Pearl Harbor (91%) are choked by mangroves. As mentioned in Section 3.4.1.1, the Navy is taking an approach to enhance endangered species habitat on Navy land when the enhancement is not in conflict with the military mission. This would be done with the ultimate goal of de-listing of the species.

Mangrove removal has been funded in the past, with AT/FP money, due to the presence of vagrants living in the thickets. But after 1-2 years, mangrove seedlings have re-colonized the areas and are now up to 3 feet tall. Mangroves have also encroached onto historic Hawaiian fishponds. Community groups, such as the Hawaiian Civic Clubs, have expressed interest in working with the Navy to restore the fishponds and remove mangrove. Mangroves also limit the view plane into the harbor, and encourage illegal dumping, further degrading wetland areas. USFWS Refuges contain two overlay refuges at Pearl Harbor (Honouliuli Unit and Waiawa Unit (Section 3.3.2.3). The Navy may consider working with USFWS to jointly manage additional wetland habitat at Pearl Harbor. A continued mangrove removal program, to include mature tree removal and maintenance through seedling removal, is described in Section 9.3.

Wetlands act as filtering agents for streams flowing into Pearl Harbor, and, coupled with riparian habitat along streams, buffer against high-flow events and excessive sedimentation. Wetlands at stream mouths in Pearl Harbor, and riparian areas upstream, therefore, serve a valuable purpose in maintaining water quality in the harbor. Removing mangroves may increase detrimental sedimentation effects of high-flow events. Native vegetation should be restored along riparian corridors and wetland areas to mitigate against the unintended consequences of mangrove removal. These wetlands and riparian areas often cross jurisdictional boundaries, and must be protected via partnerships with local watershed protection groups. One such example is the Aiea Community Watershed Committee, which has reached out to CNRH to form a partnership protecting these aquatic resources. The Navy's goal is to enhance their relationship with such groups to jointly protect our resources. A wetland and stream inventory

and restoration framework needs to be developed for implementing this goal. A project as such is described in Section 9.3.

1. No Net Loss of Wetlands

JBPHH IEP ensures that there is no net loss of wetlands on Navy-controlled lands, while simultaneously establishing and/or enhancing native wetland species and reducing alien wetland species. CNRH has developed a plan for mangrove removal at PHNC. They have completed a pre-phase in which 0.5 ac (0.2 ha) were removed. During phase one approximately 10 ac (4 ha) were cleared. During the second phase 49 ac (20 ha) were cleared. Phase three has not been started yet, but approximately 102 ac (41 ha) are planned to be cleared during this phase (NAVFAC PAC Environmental 2008b).

2. Update of Pearl Harbor Wetland Inventory

The Navy updated the Pearl Harbor Wetland Inventory in 2007 (NAVFAC PAC 2007d) which updated information contained in the 1999 Pearl Harbor Wetland Inventory (USACE 1999).

3. Formal Wetland Training for Natural Resource Staff

The Navy provides for formal wetland training for CNRH, NAVFAC HI, and NAVFAC PAC natural resources and environmental staff. Training includes information on wetlands regulations and policy in order to identify and manage wetlands at JBPHH to maintain no net loss of wetlands values.

3.4.2 Natural Resources Studies

DODI 4715.3 directs DOD agencies to manage natural resources through principles of ecosystem management. Ecosystems with large proportions of native species are to be protected, and habitat restoration activities are to focus on these habitats. Areas with significant natural resource values, as shown in Table 3-6, are to be managed to conserve those values.

3.4.2.1 Update and/or Initiate Fauna Surveys at PHNC

The Navy updated bird surveys at PHNC including outlying areas (Makalapa Crater, NAVMAG PH West Loch Branch, Pearl City Peninsula, Red Hill Storage Area, Waiawa Watershed; NAVFAC PAC 2006a). The Navy initiated herpetological surveys at PHNC and outlying areas (NAVFAC PAC 2006d). These surveys provide data to NAVFAC PAC Natural Resource staff regarding bird, amphibian, and reptiles species known to occur at PHNC. The data is used to continue the Navy's efforts to monitor, conserve and/or sustain the native animal species found at PHNC.

3.4.2.2 Botanical Survey Updates

In 2006, the Navy completed botanical surveys at PHNC including the coastal zone, Red Hill Fuel Storage Area, and Waiawa Watershed (NAVFAC PAC 2006b, i, and j). These surveys updated the botanical surveys conducted for these same areas by Char in 1999 and 2000 (Char 2000c, 1999, 2000a and 2000b). The surveys provide needed data and information to allow NAVFAC PAC Natural Resource staff to make decisions on how to protect, conserve, and manage terrestrial plants and to identify and protect native and mature trees and pocket forests.

Recommendations for support of mangrove removal at Pouhala Marsh and PHNWR were made in the Pearl Harbor Coastal Zone Botanical Survey (NAVFAC PAC 2006b) (Section 3.4.1.4 Invasive Species). The Red Hill Fuel Storage Area Fleet Industrial Supply Center Botanical Survey (NAVFAC PAC 2006i) report recommended that native species such as ʻūlei and huehue be protected from unnecessary development. Furthermore, the report recommended monitoring areas of erosion concern at Red Hill and an effort should be made to revegetate the eroded area with native groundcover species.

3.4.2.3 Marine Biotic Resources Management and Monitoring

The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. § 1801 et seq.) enacted in 1976 and amended by the Sustainable Fisheries Act in 1996, mandates identification and conservation of essential fish habitat. Federal agencies which fund, permit, or carry out activities that may adversely impact essential fish habitat are required to consult with NMFS regarding potential impacts. Essential fish habitat is defined as those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity (16 U.S.C.§ 1802). These waters include aquatic areas and their associated physical, chemical, and biological properties used by fish, and may include areas historically used by fish. Substrate types include sediment, hard bottom, structures underlying the waters, and associated biological communities.

The Western Pacific Regional Fishery Management Council has designated all the waters around all the Main Hawaiian Islands as essential fish habitat from the shoreline to a depth of 1,300 ft (400 m) for one or more of the managed species. Therefore all of Pearl NDSA is EFH. However, no EFH Habitat Area of Particular Concern has been designated for any of these Navy areas. The Navy consults with NMFS on projects affecting the essential fish habitat quality or quantity within the waters of Pearl Harbor.

The Navy has conducted quarterly surveys of the PHEC and Pearl Harbor since 2000. These surveys have focused primarily on assessing sea turtles and corals, although data on selected macro-benthic invertebrates and fishes has also been gathered. In 2005, a detailed investigation was completed. The results were reported by Smith et al. (2006) and are included in Appendix B1. It is anticipated that during 2009, a 10 year summary report will be prepared.

The most significant threat to organisms investigated during the 2006 study is judged to be the alien, invasive species gorilla algae. It has overgrown and killed coral colonies within Pearl Harbor and degraded formerly productive fish habitat, such as Beckoning Point. Control of gorilla weed should be considered the most important priority for sustaining and protecting the fishery and benthic invertebrate resources of Pearl Harbor (Smith *et al*. 2006). Monitoring of coral communities is to continue on a periodic basis. Methods to control aquatic invasive species, such as *Gracilaria salicornia*, should be explored, possibly through a combination of reduced nitrification, manual control (super sucker), and urchin translocations. A project for alien algae control is described in Section 9.3.

CNRH Instruction 5510.20C (Appendix I1) references the DOH health advisory and encourages DOD recreational fishing to be catch and release (Section 3.4.6). In addition, the Navy has maintained the policy of limiting shorefishing to authorized personnel from Navy property from sunrise to sunset (CNRH Instruction 5510.20C). Section 9.3 presents a recommendation for a creel survey to assess fishing pressure and compliance.

Chapter 8, Coral Insert, documents the full breadth of management activities employed by the Navy to protect and enhance corals within the Naval Defensive Sea Area.

3.4.3 Use of GIS Systems

As discussed in Section 2.4, PHNC's natural resources data is being integrated into the Navy's GIS system and made available to planners and land managers to aid in decision-making. The JBPHH IEP and NAVFAC PAC Natural Resource staff ensure that newly acquired or updated natural resources information is integrated into the installation GIS database on a regular basis. NAVFAC HI has created GIS layers in geodatabase format for PHNC for the following data: (1) fauna habitat; (2) fauna special species areas; (3) wildlife management areas; (4) flora special species areas; and (5) land vegetation cover.

3.4.4 Forestry

The Navy continues to protect mature and significant trees and pocket forests at PHNC including forested areas along Waiawa and Waimano Streams in the Waiawa Watershed. The most extensive forest resource within PHNC is the mangrove forest that composes a thin band around the Pearl Harbor shoreline. There is no known local commercial potential for mangrove and the trees are considered an invasive species that chokes out native plant species and destroys habitat for federally-listed bird species. Mangrove forests are effective in providing shoreline erosion control by trapping of upland sediments; however, the Navy has been actively removing mangrove from selected portions of the shoreline at Pearl Harbor in order to improve native habitat and installation security.

Non-native forested areas exist in the interior of Makalapa Crater, Pearl City Peninsula, Red Hill Storage area, and Waiawa Watershed. Forested areas within Waiawa Watershed function primarily to control erosion at riparian areas. Flash flooding within the property adjacent to Waiawa and Waimano Streams causes flooding along the stream banks. The forested areas within Waiawa Watershed prevent excessive soil loss during these periods of high water.

Mature and significant trees and landscapes are located in the developed portions of PHNC, including the Navy family housing communities. These urban forests provide a range of amenities including enhancement of quality of life, climate control, sense of place, wildlife habitat, and aesthetic value.

Facility managers from CNRH must get approval from the JBPHH Executive Officer (XO) prior to removing any tree on base. This keeps JBPHH Command informed of tree losses. Facility managers usually consult with the NAVFAC HI landscape architect for justification to remove a tree prior to proceeding to the XO for approval.

In addition, the Navy has guidelines on tree maintenance, removal/replacement, and selection, described in the Navy Tropical Landscape Guide (DON 2003). Culturally significant and/or historic landscapes, which can include trees, are detailed in the ICRMP (DON 2008b). In addition, FCMC maintains a list of mature and/or significant trees located in Navy family housing communities. The NAVFAC HI landscape architect recommends mapping of mature and/or significant trees on JBPHH property and the preparation of a database and GIS layer (Section 9.3).

3.4.5 Community Outreach

CNRH has implemented an environmental education campaign, including a brochure entitled "Protecting Hawai'i's Environment – A Team Effort" (Appendix I10), directed at installation personnel, residents, visitors, and the general public. The objective of the campaign is two-fold: (1) strengthen the centralized repository of natural resources information; and (2) continue to

efficiently disseminate JBPHH natural resources information to in order to increase awareness among base personnel, installation residents, and the community.

Pearl Harbor's natural resource protection efforts need to be highlighted internally, to the public, and to other agencies. This promotion will increase ecological literacy on base, facilitate relationships with the public and outside agencies, and promote dialogue with other natural resource managers and scientists leading to the development of better and more efficient management practices. Section 9.3 recommends increased in-reach and community outreach.

3.4.6 Outdoor Recreation

According to SAIA definitions, outdoor recreation relates to activities that take advantage of the natural resources of an area to provide recreational opportunities for installation personnel. If there is no conflict with the installation mission, access and use by other DOD employees and the general public is recommended. Outdoor recreation activities described in this INRMP do not include the provision or management of recreational facilities generally associated with urban developments such as playgrounds, golf courses, athletic fields, hobby shops, and swimming pools.

Outdoor recreation planning is accomplished within the broader context of natural resources management where land uses are intended to satisfy both the needs for outdoor recreation as well as the preservation of natural resources. Outdoor recreation, as described in this plan, is confined to areas within the installation boundaries over which the Navy has the authority to manage.

Operational constraints, including security requirements at the installation, limit the available land suitable for development of outdoor recreation activities. In addition, the size of the on-base resident population is used to justify the demand for outdoor recreation facilities. Recreational opportunities at NAVMAG PH West Loch Branch, including Waipi'o Peninsula, are either non-existent or severely limited due to access restrictions.

The waters of Pearl Harbor and much of the surrounding land are largely off-limits for public recreational use. Current Navy regulations permit limited fishing and recreational boating by authorized personnel (e.g., military and civilian employees of DOD and their dependents and guests) in designated areas. The majority of harbor waters remain restricted due to berthing, ship movements, industrial operations, and/or safety constraints (ESQD arcs). Hunting is not permitted anywhere at PHNC. Bathing, water skiing, and recreational swimming are not permitted in Pearl Harbor.

1. Rainbow Marina

Located on Navy land, Rainbow Marina in East Loch is managed and operated by MWR to provide outdoor recreational services for authorized personnel. The Navy supported renovations and expansions to the marina in recent years in order to upgrade recreational boating facilities.

2. Boating, Sailing Canoeing, Kayaking

The Navy allows recreational boating (Photo 3-73), sailing, canoeing, and kayaking by authorized personnel in specified locations in Pearl Harbor; however, permits are required. Eligible DOD personnel may launch their own boats from Rainbow Bay Marina under permit from MWR. MWR provides many watercraft activities to authorized patrons from its Rainbow Bay Marina facilities. These activities include sailing, kayaking, canoeing classes, deep-sea fishing (by contractor in areas outside of Pearl Harbor), SCUBA diving (by contractor outside of Pearl Harbor), and boat rentals. Wind surfing is not permitted in Pearl Harbor. The Navy permits the Honolulu Canoe Club and the Pearl Harbor Yacht Club to operate their organizations from the Rainbow Bay

Photo 3-73: Sailing at Pearl Harbor

Marina. These organizations allow participation from both DOD and the general public. The Navy has maintained and promoted recreational boating policies at Pearl Harbor for MWR-authorized patrons. CNRH Instruction 5510.20C (Appendix I1) governs the entry and operation of privately owned local craft in the Pearl Harbor NDSA. This instruction provides regulations on the operation of personal watercraft, kayak operating instructions, kayak operating areas, MWR specific operations, and recreational catch and release fishing in Pearl Harbor.

3. Catch and Release Fishing

The Navy permits catch and release shorefishing for authorized personnel from Navy property from sunrise to sunset. Fishing is permitted within five designated areas (Figure 3-27, CNRH Instruction 5510.20C, Appendix I1) which are open to fishing seven days a week, 24 hours a day. Two of the designated fishing areas are open to the general public (Areas 2 and 3, Pearl City Peninsula, East Loch, and Aiea Shoreline). Two of the designated fishing areas are open only to the residents (Area 1, Ford Island; Area 5, Hospital Point). Area 4 (Ford Island Bridge and northeast Ford Island) is open to DOD Card Holders only. The fishing restrictions allow only for catch-and-release pole fishing from the shore. Fishing from privately-owned boats is prohibited. Commanding Officers of ships moored in Pearl Harbor but outside of the Shipyard may authorize crewmembers to fish from their own ship's decks. Shoreline fishing is also authorized from Navy-owned land at Iroquois Point/ Pu'uloa, which is managed under long-term lease by the Iroquois Point Club and Resort. The general public can fish from the bridge that crosses the Iroquois Point lagoon, from the shore area in the northeast where the lagoon opens up into the channel, and on the south ocean side in the area where the canoes are located.

Public fishing from non-Navy (e.g., SOH) lands is regulated by SOH DLNR which is responsible for enforcement of fish and game regulations on non-Navy lands around the harbor. However, public fishing by unauthorized personnel from Navy land occurs regularly and openly in many areas. In addition, a variety of illegal fishing methods are employed including the use of undersize nets, spears, and fish/crab traps. The majority of the illegal methods occur in remote areas where enforcement is difficult.

Consumptive fishing from Navy land at Pearl Harbor is not permitted due to concerns about contaminated fish and shellfish (Section 3.2.6.1). In 1998, SOH DOH issued an advisory (Photo 3-74) warning based on the Navy's preliminary remedial investigation results that humans should not consume fish and shellfish caught in Pearl Harbor, posted warning signs in various locations around the harbor, and published multilingual brochures warning of possible health effects associated with eating fish and shellfish from the harbor. The consumption of contaminated fish and shellfish from Pearl Harbor could present a potential health concern. The Navy conducted an environmental investigation and risk evaluation of Pearl Harbor sediment and tissue.

Photo 3-74: DOH Health advisory regarding contaminated fish & shellfish at Pearl Harbor

The Navy's Remedial Investigation report (DON 2007a) concluded that there potentially may be human health risk concerns if people consume seafood caught in Pearl Harbor. Additional investigation is underway to further evaluate sediment and fish in Pearl Harbor.

4. Pearl Harbor Bike Path

The Pearl Harbor Bike Path follows the historic OR&L right-of-way around Pearl Harbor. The bike path extends along the Pearl Harbor shoreline from the Arizona Memorial Visitor Center, is closed at the Admiral's Boat House, resumes south of the boathouse, and extends to Waipahu Depot Road at the northwest corner of Waipi'o Peninsula and is maintained by the CCH. A portion of the path, from the Arizona Memorial Visitor Center to Waipi'o Point Access Road, is on Navy property. From that point, it turns into a SOH-owned right-of-way. The bike path is maintained by the CCH.

5. Other Recreational Opportunities

Recreational use by installation personnel is limited to casual bird watching and nature study. No formal programs exist for such activities for base civilian and military personnel. The Navy has been supportive of USFWS efforts to build a public overlook at PHNWR Honouliuli Unit in order to provide outdoor recreational activities to JBPHH personnel and the general public. The Navy has continued to promote public events at PHNC including the Ford Island Fun Run and canoe regattas at Pearl Harbor. The Navy has prepared a self-guided walking history tour of Ford Island (Appendix I12).

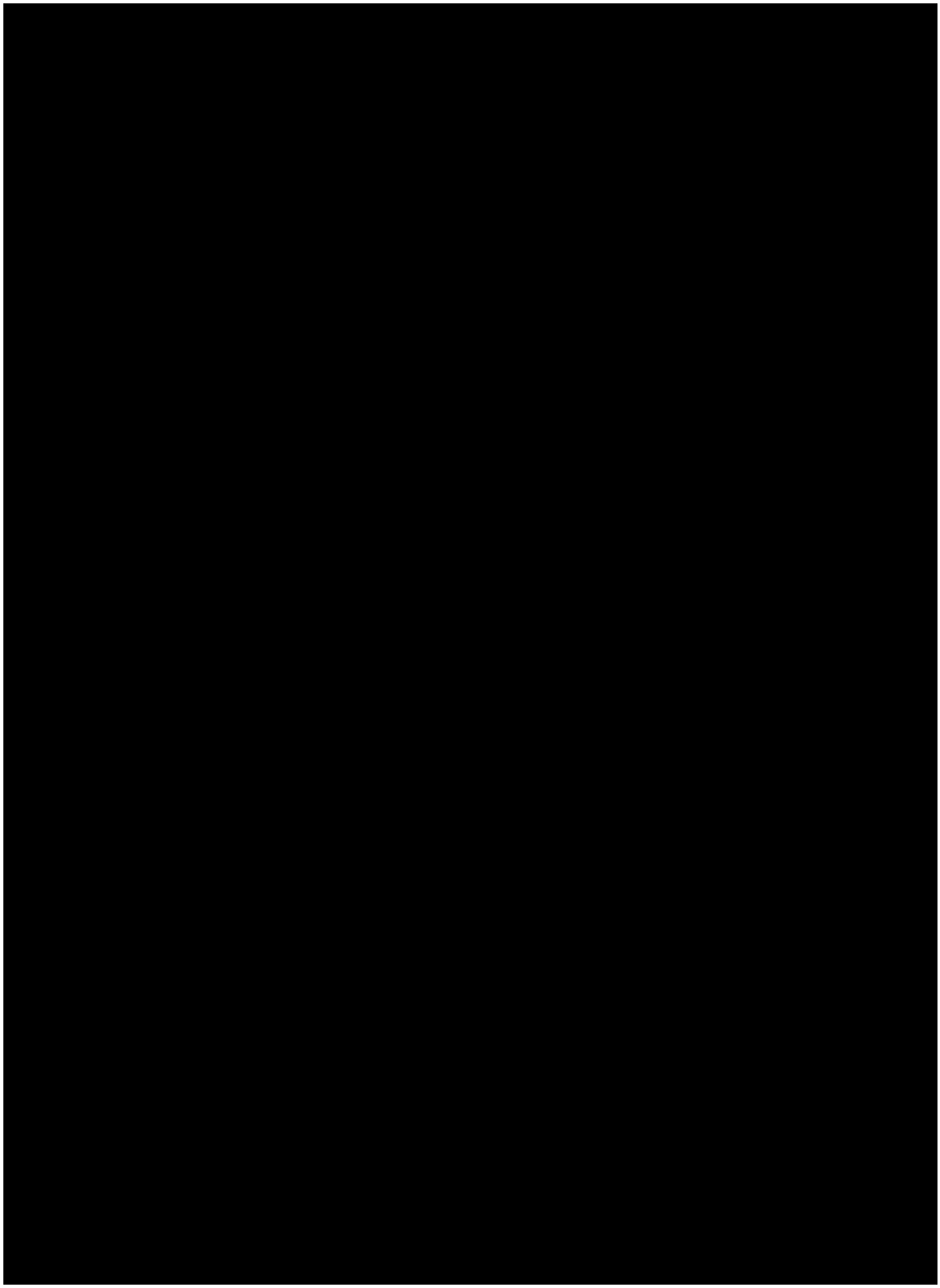


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Figure 3-27: Authorized Fishing Areas at PHNC

3.4.7 Land Management

1. Base Planning

Land management at PHNC and other Navy installations is governed, in part, by DODI 4715.3 (DOD 1996) "Environmental Conservation Program" and ecosystem management guidelines. JBPHH staff follow a routine procedure to assure coordination among facilities planners, resource managers, and government agencies. The JBPHH IEP is the primary point of contact to provide relevant information on issues with potential to affect waterbirds or other protected species, such as sound levels, direct habitat loss due to clearance and construction, proximity to neighboring habitats, and sensitivity of the species to disturbance. The Navy continues its policy of reducing point source pollution for JBPHH through identification of pollution sources and their reduction and/or elimination. The Navy continues to utilize BMPs during earthwork and construction and storm drain design in order to maintain stabilize soil conditions and provide erosion control. The Navy continues to maintain vegetation along shoreline segments in order to stabilize the shoreline and minimize siltation in Pearl Harbor. The Navy removed 59.5 ac (24 ha) of mangrove (an invasive plant species) from PHNC and permitted the removal of mangrove at PHNWR Waiawa Unit in an effort to support native vegetation and habitat at Pearl Harbor. The Navy continues its policy of non-point source pollution prevention for JBPHH lands including the identification of non-point sources and their reduction and/or elimination. Section 9.4 recommends the development of a Pearl Harbor Ecological Protection and Restoration Plan to be developed in conjunction with neighboring land owners and researchers.

2. Landscape Design

The Navy continues to utilize native plants in landscape and enhancement projects at the Lualualei INRMP Study Area. A Presidential Memorandum, released on April 26, 1994, directs federal agencies, "where cost effective and to the extent practicable, to use regionally native plants for landscaping", along with employing landscape practices that conserve water and prevent pollution. Similarly, SOH law HRS 103D-408 requires the State to incorporate indigenous and Polynesian-introduced plants into its landscaping projects whenever and wherever feasible.

Native Hawaiian plants are defined as those that arrived to a location on their own via natural processes, typically by 'wind, water or wing.' This newly introduced species is considered indigenous, meaning it is now native to Hawai'i as well as elsewhere in the world. Once this species has been in Hawai'i long enough for evolution to differentiate it significantly from its original ancestor(s), it is then considered endemic to Hawaii. This means the particular species is completely unique to Hawai'i and can be found nowhere else in the world. Native plants have adapted to survive in harsh and often inhospitable conditions. They often require less water, care and maintenance. They are also an important part of a region's biological and cultural heritage. This is particularly true in Hawai'i where native plants were used for food, cordage, medicine, clothing, and construction. The use of native plants in ornamental landscapes encourages cultivation, which in turn helps prevent extinction of species.

Hawai'i has approximately 1,100 known native plant species. Of these plants, 90% are considered endemic. This is due to the age of the island chain and our isolation in the middle of the Pacific Ocean. These two factors, coupled with the fact that Hawai'i was once completely void of many of the plant predators common to the rest of the world, has resulted in the diversity that has made native Hawaiian plants very unique.

Polynesian Introductions:

Approximately 33 species of plants were brought to Hawai'i by Polynesian voyagers in their canoes. These plants are not native but introduced species, although many have been here for over 1,000 years. These plants are an integral part of the Hawaiian culture, like Native Plants as they were used for life's daily needs. As with native species, these introduced plants are adapted to Hawaii's environment. However, plants that are appropriate in one location may not be appropriate in another. It is best to plant Polynesian-introduced species in conditions similar to where they would naturally be found.

Native plants that are appropriate for landscaping in one location may not be appropriate in another. NAVFAC HI's landscape architects plant native plants in conditions similar to where they would naturally be found and choose species and sizes appropriate for each Naval installation to ensure the plants selected will have an increased chance of survival. The landscape architect must use personal knowledge and experience in selecting the appropriate materials for each specific situation. To ensure native plants in their wild habitat are protected and perpetuated, plants are acquired from nurseries, growers and landscape contractors that are familiar with the laws and ethics associated with the cultivation of native plants.

3. PHNWR Honouliuli and Waiawa Units

The Navy worked with USFWS for the management of the overlay refuges; to improve vehicular access to PHNWR Waiawa Unit; and to provide support to the USFWS in its efforts to develop a public overlook at PHNWR Honouliuli Unit.

4. Land Management Restrictions during Training

Exercise planners confer with NAVFAC HI environmental planners. The Navy prohibits vehicle traffic off existing roads, the use of rocks from rock piles or walls for training purposes, and establishment of new vehicle tracks during training maneuvers. In addition, during training maneuvers, digging, including entrenchments and foxholes, are prohibited, except in areas specifically designated by the exercise planner. No new placement of barbed wire or concertina wire or fences are allowed near signs marking the presence of sensitive ecological areas during training. No road, trail, or fire break clearing is allowed during maneuvers without permission from the exercise planner. No grading or construction of buildings or other permanent structures is allowed without permission from the exercise planner.

5. Regulatory Coordination and Environmental Documentation with Regard to MDSU-1 Training

The Navy continues early coordination with regulatory agencies and to prepare environmental documentation as appropriate prior to MSDU-1 training. These activities are necessary to reduce environmental impacts and to assist with the development of any required mitigative measures.

6. On-going RI/FS Program

As described in Section 3.2.6.1, the Navy completed a RI for Pearl Harbor to characterize chemical contaminants in sediments and marine life in the harbor and evaluate the potential threat of these chemical contaminants to human life and the environment. The Navy is in the process of completing a work plan for conducting a Remedial Investigation Addendum to further evaluate contaminant concentrations in sediment and fish in Pearl Harbor.

3.4.8 Flood Plains

Section 3.2.6.1 provides a description of the flood insurance zones present at PHNC. There are no floodplain program elements associated with PHNC. As noted in Section 3.4.7, all new construction is reviewed by NAVFAC HI Environmental to ensure compliance with EO 11988 Flood Plain Management.

3.4.9 Law Enforcement

Base law enforcement is responsible for patrolling the restricted portions of PHNC. The family housing communities that have unrestricted access are patrolled by a security contractor and the Honolulu Police Department (HPD). PHNC military, civilian, and contractor security forces work with the NAVFAC HI Natural Resources Program Manager in reporting any incidents observed pertaining to Hawaiian monk seals on the beach. They enforce beach and fishing restrictions, and ensure that the public does not disturb monk seals hauled out on the beach. However, for reporting violations of natural resources laws, the Navy security forces report any incidents to State officials.

3.4.10 Wildland Fire

The Navy continues to maintain security fencing and fire breaks at both Red Hill Storage Area and Waiawa Watershed in order to minimize fire hazards at those outlying properties. Wildland fires have not been an issue at PHNC. The FFD would respond to any fires at PHNC and outlying communities. In case of fire during training exercises, all fires will be reported to the FFD and personnel will stop training and begin to fight the fire. Personnel will continue to fight the fire until released by the fire department.

3.4.11 Leases and Encroachment

Prior to 2005, CNRH outleased two parcels of land at Pearl City Peninsula under two 5-year lease agreements: (1) 19.5 ac (7.9 ha) to Takano-Nakamura Nursery for $12,000 per year; and (2) 18.2 ac (7.4 ha) to Gushing Waters for $21,000 per year. The Gushing Waters parcel was vacated in 2005. The Takano-Nakamura Nursery lease expired in 2007; although, the tenant has stayed on and continues to pay rent which is now $16,000 per year. There is an adjacent 3 ac (1.2 ha) agricultural parcel at Pearl City Peninsula; however, that area is not currently being outleased (NAVFAC HI 2008).

Under the Navy's agricultural outleasing program, Pu'uloa Farms leases 1,025 ac (415 ha) at West Loch; however, only a portion of that is actively farmed for watermelons, tomatoes, and corn. The lease started April 1, 2003, and expires March 31, 2023. The rent was recently reset to $30,600 per year, and resets every five years (NAVFAC HI 2008).

CNRH developed an Encroachment Management Plan (Navy Region Hawaii 2010) in order to identify at early stages potential community development, or changes in local laws/regulations that may affect Navy operating procedures. The Navy continues to monitor adjacent off-site development at Red Hill Storage Area and Waiawa Watershed to minimize adverse impacts (fire hazard, public safety, flooding, runoff, groundwater pollutants, encroachment).

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CHAPTER 4
LUALUALEI

CHAPTER FOUR: LUALUALEI

4.1 CURRENT CONDITIONS AND USE

4.1.1 Lualualei INRMP Study Area Information

NAVMAG PH Lualualei Branch and NRTF Lualualei are included in the Lualualei INRMP Study Area for JBPHH. They are located within the Lualualei coastal valley on the southwestern shore of O'ahu (Figure 4-1). NAVMAG PH Lualualei Branch is 7,498 ac (3,034 ha) and NRTF Lualualei is 1,700 ac (687 ha); the facilities are contiguous.

4.1.1.1 General Description

1. NAVMAG PH Lualualei

NAVMAG PH Lualualei Branch (Photo 4-1) contains an extensive munitions magazine complex, warehousing, operating buildings, community and personnel support facilities, and a considerable amount of open space. There are 164 permanent, 133 semi-permanent, and 18 temporary buildings covering 554 ac (224 ha) of the naval magazine branch. The munitions storage complex contains 266 magazines utilizing 12 ac (4.8 ha) of land (DON 2008b). NAVMAG PH Lualualei Branch includes developed lands with limited natural resource value and undeveloped lands with significant natural resources value.

Photo 4-1: NAVMAG PH Lualualei Branch

2. NRTF Lualualei

NRTF Lualualei (Photo 4-2) includes transmitting towers, an area of vacant housing, and operational support facilities (Figure 4-1). The Navy and the USCG jointly use the facility, and the two 1,500-ft (457-m) high transmitter antennae and associated open-space occupy most of the land.

Photo 4-2: antenna fields at NRTF Lualualei

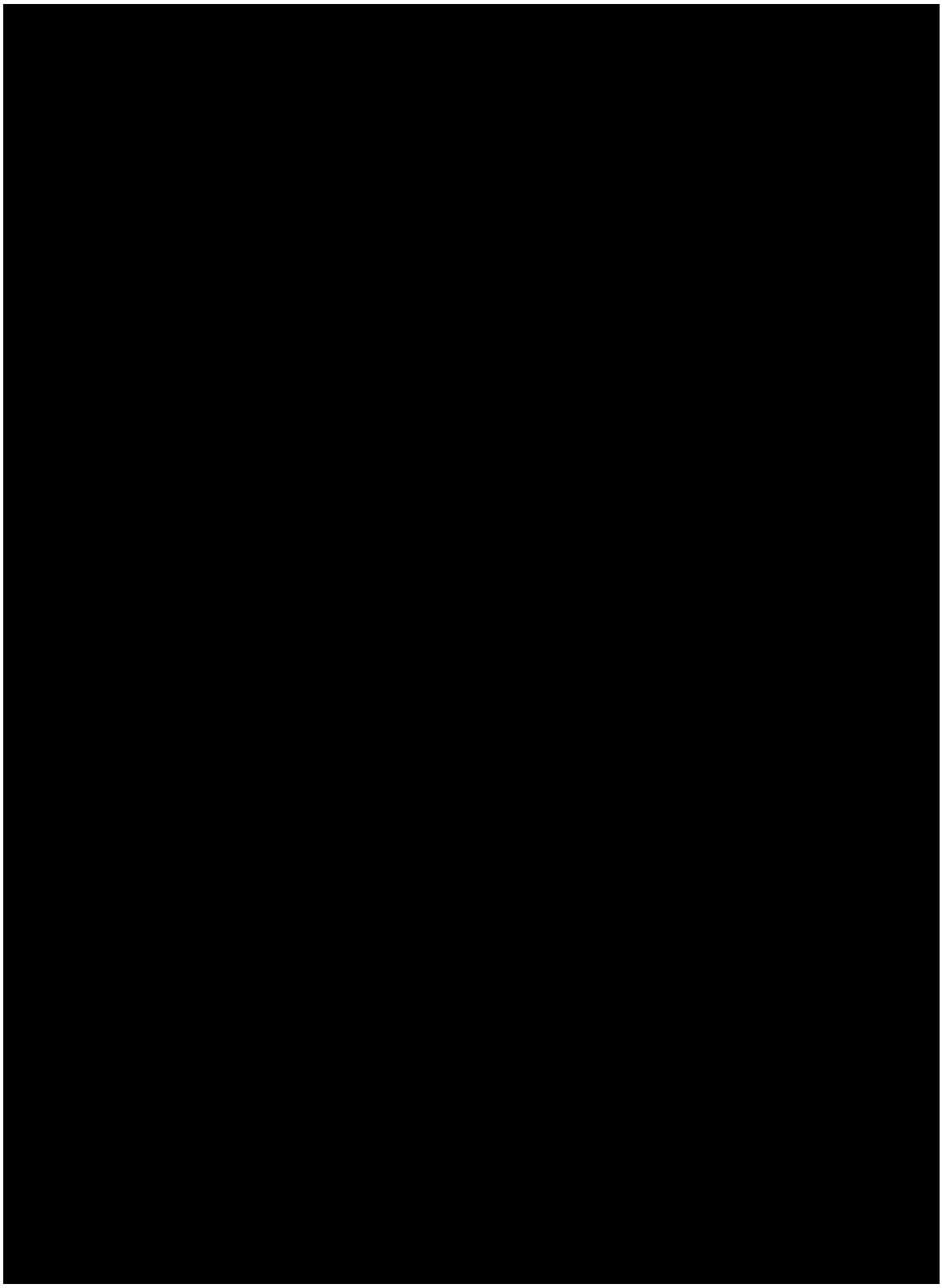

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Figure 4-1: Lualualei Study Area

4.1.1.2 Land Use Constraints

Land use constraints at the Lualualei INRMP Study Area result from both the military mission and protected species and sensitive habitats located there. Access is limited to assigned personnel and visitors on official business.

1. NAVMAG PH Lualualei Branch

NAVMAG PH Lualualei Branch functions are conducted in areas that are developed only to the degree necessary for mission accomplishment and remote from public habitation areas. Consistent with its mission, NAVMAG PH Lualualei Branch ammunition storage and ordnance operations require that large areas of land be set-aside for safety buffers referred to as ESQD arcs (Figure 4-2).

ESQD arcs essentially identify areas around DOD ordnance handling facilities that could potentially be damaged or destroyed by an ordnance explosion. The arcs are established to limit exposure of persons and property to injury or damage in accordance with DOD criteria. There are several natural resource constraints affecting NAVMAG PH Lualualei Branch: (1) the presence of federally protected flora and fauna species and critical habitat in the upland portions of the subinstallation (Figure 4-2); (2) mature and significant trees and landscapes in the administration portion of the installation; (3) four Special Management Areas (SMAs) totaling about 685 ac (277 ha) (Figure 4-1); and (4) the steep slopes that surround the subinstallation on the east. Section 4.3 presents a description of the protected species and habitats located in the Lualualei INRMP Study Area.

2. NRTF Lualualei

NRTF Lualualei provides radio transmission facilities, which create potential threats to public health and safety. To ensure that high-density electromagnetic power will not constitute a hazard, EMR zones are designated around transmitter sites (Figure 4-2). Although there are no ordnance activities conducted at NRTF Lualualei, ESQD arcs associated with ordnance operations at the adjoining NAVMAG PH Lualualei Branch impact land use along the eastern boundary of the installation (Figure 4-2).

There are several natural resources constraints affecting NRTF Lualualei. These include: (1) the presence of federally protected flora and fauna species and critical habitat (Figure 4-2); (2) mature and significant trees and landscapes in the administration and former housing portion of the installation; and (3) Niuli'i Ponds Wildlife Refuge, a wetland, where federally-listed endangered bird species occur (Figure 4-2). Section 4.3 presents a description of the protected species and habitats located in the Lualualei INRMP Study Area.

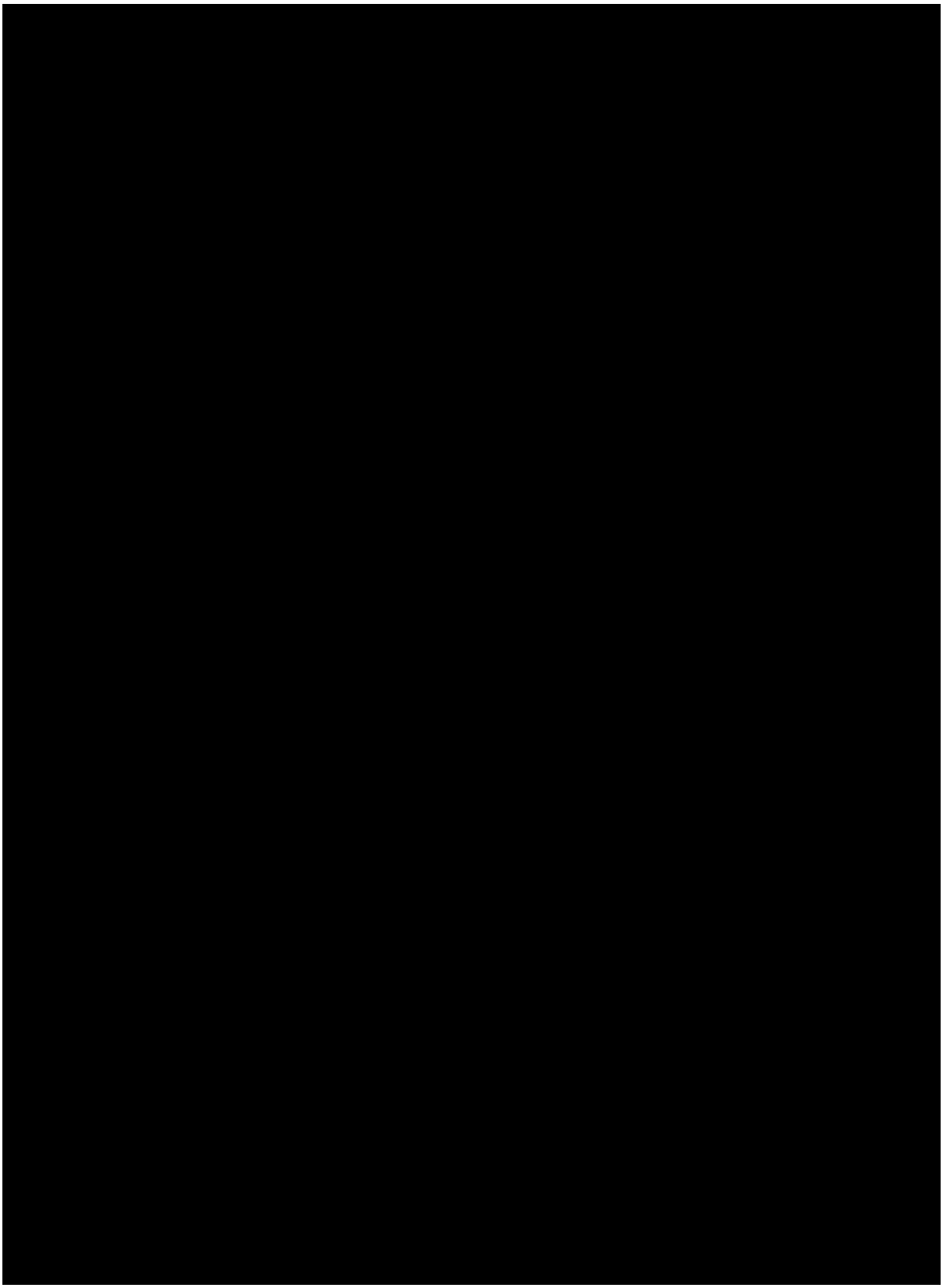

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Figure 4-2 Constraints, Lualualei Study Area

4.1.1.3 Land Use Opportunities

No new land use opportunities for military mission training were identified at the Lualualei INRMP Study Area.

4.1.1.4 Operations and Activities

1. NAVMAG PH Lualualei Branch

NAVMAG PH Lualualei Branch receives, renovates, maintains, stores, and issues ammunition, explosives, expendable ordnance items and weapons, and technical ordnance material. The magazines are located primarily in the center, the administrative and support facilities in the southwest corner, and undeveloped lands encompassed by the ESQD arcs on the east side of the naval magazine branch.

2. NRTF Lualualei

NRTF Lualualei transmits state-of-the-art high and low frequency radio signals for the navigation of Navy vessels throughout the Pacific. A communications/information technology area is located in the center and antenna fields are distributed throughout NRTF Lualualei.

4.1.1.5 Abbreviated History and Pre-Military Land Use

NAVMAG PH Lualualei Branch and NRTF Lualualei are located in Lualualei Valley which is the largest coastal valley on the leeward side of O'ahu. It is located in the Lualualei ahupua'a. Native Hawaiians initially occupied the valley on a temporary basis from as early as the mid-1400s and continuing through the 1600s. Early settlement in the Lualualei Valley was along the coast and the main subsistence was fishing. In addition, salt was collected from an area just north of the twin hills of Pu'u o Hulu. The back dune marsh areas of Lualualei may also have been used intermittently for aquaculture (NAVFAC PAC 1998).

Beginning around the mid to late 1600s to the early 1800s, permanent Native Hawaiian habitation sites were established as the population within the valley increased. The upper part of Lualualei is dissected into five drainages fed by springs that were once perennial. Soils in terraces and fans along the drainages provide optimal conditions for Polynesian introduced cultigens such as taro, banana, and sweet potato. Traditional Hawaiian habitation sites are more concentrated in the upper elevations where soils are deeper and rainfall more predictable (NAVFAC PAC 1998).

Traditional Hawaiian sites and features appear to represent religious and ceremonial activities including heiau and burials; permanent habitations including kuleana, platforms, enclosures, and terraces; temporary habitations including terraces, rock shelters, temporary field shelters, and walls; agricultural sites including garden areas, enclosures, animal pens, mounds, terraces, and water diversions; and lithic work stations. The majority of these sites are found in the upland areas, although traditional Hawaiian components are distributed throughout the valley (NAVFAC PAC 1998).

Changes in land tenure and use in Lualualei Valley are documented from the 1850s. Most of these changes occurred during the period commonly referred to as the Great Māhele (1848) – the division of lands signaling the transition from traditional Hawaiian concepts of land ownership to the western concept of private land ownership. After the Great Māhele, Lualualei

Valley was designated as "Crown Lands." Ranching in the Lualualei Valley began in 1851 and continued through 1902 with Crown leases awarded to four individuals (Jarret, Dowsett, Galbraith, and Paul F. Manini). Archaeological site and feature types linked with historic-era ranching include walls, cisterns, cattle troughs, salt licks, house sites, roads, and curbstone alignments (NAVFAC PAC 1998).

Sugarcane cultivation began in the Lualualei Valley after the Wai'anae Sugar Company began operation in the Wai'anae Valley in 1878. By 1892, 300 ac (121.4 ha) of sugarcane had been planted in central Lualualei. A railroad, irrigation ditches and flumes, and reservoirs were constructed. "Cane Camp," a plantation housing area, was established adjacent to the railroad tracks by Niuli'i Reservoir. The Wai'anae Sugar Company ceased operations in 1946 (NAVFAC PAC 1998).

Following the overthrow of the Hawaiian monarchy in 1893, former Crown Lands were offered as homesteads. The first lots in Lualualei were developed in 1902 and others followed in 1907 and 1912. Some of the lots were in areas that the Wai'anae Sugar Company had developed for sugarcane planting in the central Lualualei Valley. Three series of homesteads were awarded in Lualualei Valley between 1903 through 1912. Lots 1 through 9 located at the back of the valley were awarded in 1903; lots 10 through 20, located in the coastal portion of the valley, in 1907; and lots 101 through 214, located within the north-central plain, in 1912. By 1912, L. L. McCandless had leased or purchased most of the first series of homestead lots (1-9) for use as a cattle ranch. In addition, McCandless had subleased use-rights for some of these areas to the Sandwich Island Honey Company for establishing apiaries. The McCandless Ranch continued to raise cattle in the valley until 1929 (NAVFAC PAC 1998). The first presence of the U.S. military in Lualualei Valley was in 1923 with the beginning of construction of the Kolekole Pass.

1. NAVMAG PH Lualualei Branch

The U.S. Navy has used a portion of the valley for a naval magazine since the mid-20th Century (DON 2008b). Between 1929 and 1931, the Navy acquired more than 8,300 ac (3,358.9 ha) in the Lualualei Valley, most of which was the former McCandless Ranch (DON 2008b). Building plans for the magazines were completed between 1930 and 1931 and construction occurred between 1932 and 1934. These structures were cast-in-place concrete construction, many in a Renaissance Revival style, with housing and administration buildings often having rusticated corners, quoins, and other decorative details. Most buildings have a steel frame pivot or wooden, double-hung windows, and flat roofs were built-up roofing over concrete, while pitched roofs were of steel or wood construction (NAVFAC PAC 1998).

The Navy commissioned the NAD Oahu on 1 May 1934. The depot was expanded at the beginning of World War II when an additional 72 magazines, storage buildings, and housing were added to the existing lands. These were built in the same style as the 1930s buildings, but most were not as decorative. Many of the non-magazine structures were constructed of less durable materials such as wood or steel frame construction and wood or metal finishes (NAVFAC PAC 1998). Another 245 ac (99.1 ha) were acquired in 1945. Since that time, 696 ac (281.7 ha) have been returned to SOH (CNRH 2006).

The primary Cold War activities at NAVMAG PH Lualualei were extensions of the 1930s and World War II functions, including storage and renovation of ordnance. During this era there was no activity or construction of exceptional importance, although three construction episodes were undertaken: (1) Korean War era (1950 to 1954) buildup to renovate and manage ammunition; (2) quality of life improvements (1970s); and (3) additional quality of life improvements (1980s and 1990s) as well as new facility construction to meet the requirements for advanced weapons

(NAVFAC PAC 1998). As part of the Navy's Shore Establishment Reassignment, NAD Oahu was disestablished on 1 July 1974. NAVMAG PH Lualualei Branch was subsequently established as a tri-service facility providing ordnance support to the Navy, Air Force, and Army (CNRH 2006).

2. NRTF Lualualei

In 1933, under provisions of the Hawaiian Homes Commission Act of 1921, the Territorial Governor gave the 1,729-ac (699.7-ha) lot in Lualualei Valley to the Navy for a radio transmitting station. The executive order which ceded the land stipulated that should the facility cease to be required or used by the Navy as a radio transmitter, it shall revert to its previous status. The Navy commissioned the Naval Radio Transmitting Station Lualualei on 22 December 1933 and activated in 1936. NRTF Lualualei has been in continual use as a Navy radio transmitting facility since acquisition (DON 2008b).

4.1.1.6 Regional Land Uses

Most of NAVMAG PH Lualualei Branch and all of NRTF Lualualei are within the SOH State Agricultural District, with the upland areas of NAVMAG PH extending into the State Conservation District. The northwest corner of NRTF Lualualei touches an Urban District containing the town of Mā'ili (SOH LUC 2009). Both installations are zoned by the CCH as F-1 (Military and Federal Preservation). The upper slopes of NAVMAG PH Lualualei Branch are zoned P-1 (Restricted Preservation District). Areas adjacent to the western edge of NAVMAG PH Lualualei Branch and lands surrounding NRTF Lualualei are either zoned AG-2 (General Agricultural District) or Country District (CCH 2008).

4.2 GENERAL PHYSICAL ENVIRONMENT

The discussion of the general physical environment is divided into six subsections (4.2.1 through 4.2.6): (1) physical geography; (2) topography; (3) climate; (4) geology; (5) soils; and (6) hydrology – including surface water resources and hydrogeology (groundwater resources). General island-wide descriptions of these resources are presented in Section 2.2; the following discussion addresses Lualualei (Photo 4-3) and its environs.

Photo 4-3: Panoramic view of Lualualei Valley from Kolekole Pass Road

4.2.1 Physical Geography

A general discussion of the physical geography of the Hawaiian Islands and O'ahu is presented in Section 2.2.1. The Lualualei Valley is a caldera remnant of the Wai'anae Volcano. It is the largest valley in leeward O'ahu and is comprised of a large, flat valley floor. It is bound by Wai'anae Valley to the north, Nānākuli Valley to the south, the Wai'anae Range on the west, and the Pacific Ocean on the east. NAVMAG PH Lualualei Branch occupies most of the inland portion of the valley, and in places, extends to the ridge of the Wai'anae Range. NRTF Lualualei is located on the western boundary of NAVMAG PH Lualualei Branch.

4.2.2 Topography

A general discussion of the topography of O'ahu is presented in Section 2.2.2. Bound on the west by the 22 mi (35 km) long Wai'anae Mountain Range, the 6,500 ac (2,631 ha) Lualualei Valley is located between the Wai'anae Valley to the north and the Nānākuli Valley to the south. It is comprised of a large, flat valley floor, which includes a number of smaller valleys, gently sloping into an alluvial fan. NAVMAG PH Lualualei Branch consists of essentially flat lands at an elevation of 80 ft (25 m) above msl along Fence Road, gently sloping in the magazine area, and graduating to steep mountainous slopes in the Wai'anae Range with a maximum elevation of 3,127 ft (953 m) (Figure 4-3). NRTF Lualualei ranges in elevation from 10 ft (3.1 m) above msl at the western corner to 100 ft (30.5 m) above msl on the west side, with slopes ranging from 5 percent to 15 percent (Figure 4-3).

4.2.3 Climate

A general discussion of the climate for the island of O'ahu is presented in Section 2.2.3. The climate of Lualualei Valley is warm and dry with a mean maximum temperature of about 85° F (29.4° C) in the summer and about 80° F (26.7° C) in the winter months. The highest recorded temperature of the Wai'anae district was 96° F (35.6° C), but rarely is 90° F (32.2° C) exceeded. Temperatures may fall as low as 50° F (10° C) during the winter nights.

Rainfall at the installation is highly variable due to the many different tropical features and elevations. Average annual rainfall on the summit crest near Kolekole Pass is about 51 in (130 cm) per year, and decreases to less than 20 in (50 cm) at the Wai'anae Coast (Giambelluca and Schroeder 1986). Even where the elevations are similar, the amount of precipitation can still vary considerably. The north side of Lualualei Valley, below Kolekole Pass and Pu'ukū Makali'i has an average annual rainfall of 20 to 67 in (50 to 170 cm), compared to an area in the southern section near Pōhākea Pass where there is an average precipitation of 47 to 150 in (120 to 380 cm).

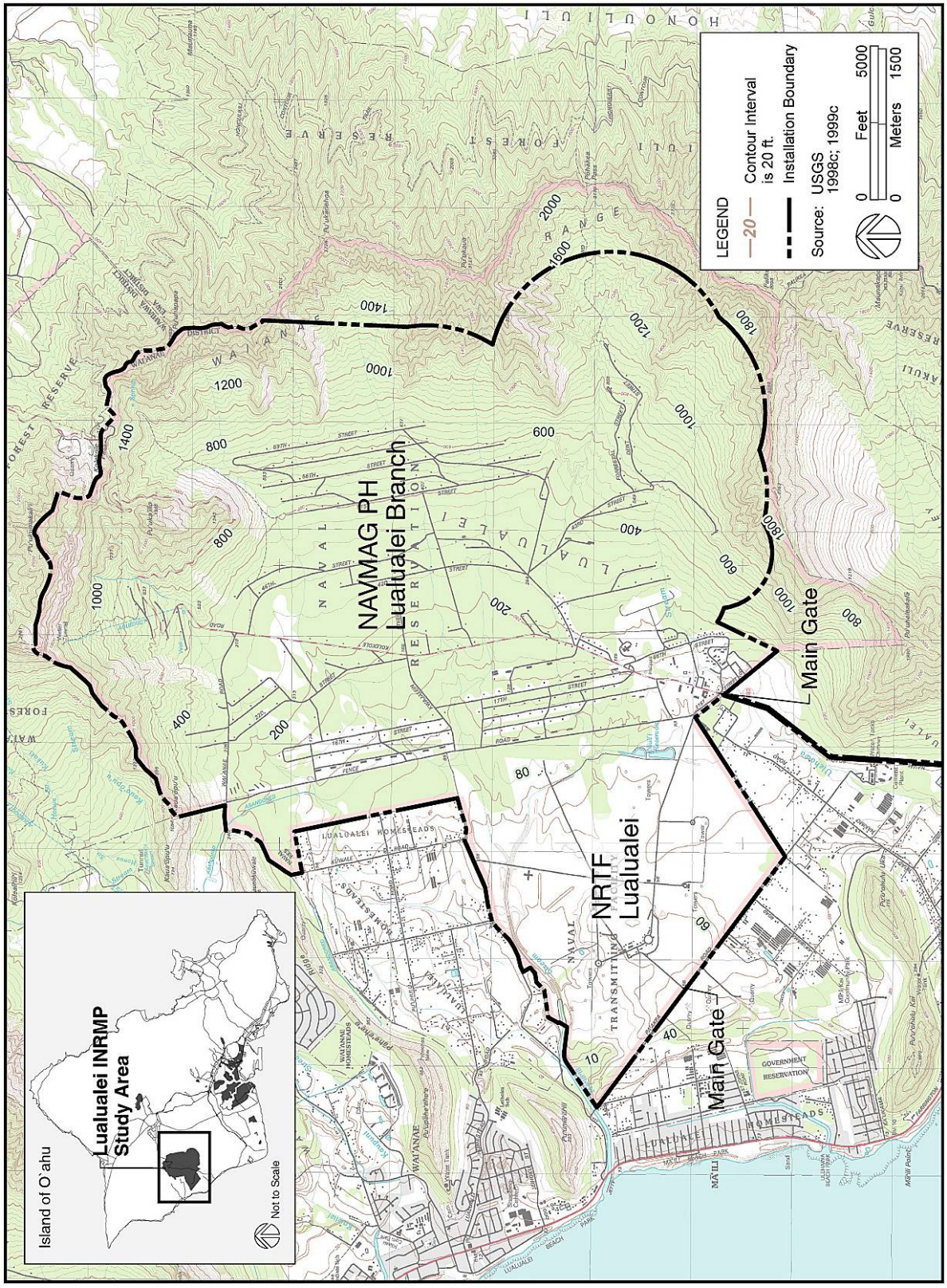

Figure 4-3: Topography, Lualualei Study Area

Pan evaporation rates are in the range of 40 to 90 in (100 to 230 cm) per year in the lower portion of the installation. The extreme difference between rainfall and pan evaporation rates is indicative of a very dry, coastal climate (DON 2001b).

4.2.4 Geology

A general discussion of the geology of O'ahu is presented in Section 2.2.4. The Lualualei Valley is a caldera remnant of the Wai'anae Volcano. Lualualei Valley is comprised of non-lithified alluvial fill materials that are largely the result of stream deposition. The valley, like many low-lying areas on O'ahu, was often submerged when ocean levels were relatively higher than they are today. As the sea retreated from this high stand, fans from the uplands washed onto the clay plain. Later a 25-ft (7.6-m) high sea stand cut a notch into the coastal edge of the coastal barrier. Fans formed when the level dropped again. With the current interglacial melting of the ice, sea level has risen and stream mouths have been drowned and become sediment choked. In Lualualei Valley, the notch for the 25-ft (7.6-m) sea stand forms the seaward boundary of NRTF Lualualei.

The accumulated alluvial sediment in the valley has been found to be over 1,200 ft (366 m) thick and could perhaps extend to a depth below sea level (MacDonald *et al* 1977). The high cliffs along the eastern half of the valley are comprised primarily of Wai'anae basalt lava flows (Stearns and Vaksvik 1935). The lava flows are separated on the northern and southern ends of the valley by interspersed masses of volcanic breccias, vertical dike complexes, and volcanic tuff.

4.2.5 Soils

Table 4-1 provides a summary of the soil types found in Lualualei INRMP Study Area and Figure 4-4 depicts the locations of the soil types. The soils reflect the volcanic geology and erosional history of the region. One of the predominant soil types of the study area are soils of the Lualualei Series which have a high shrink-swell potential that can cause cracking of the soils and foundations of structures built upon these soils (USDA 1972). In addition, the presence of feral ungulates, including cattle, pigs, and goats, is a potential threat to the watersheds within the valley because the animals browse and feed on vegetation and compact the soil, which tends to impede soil percolation of rainwater. This reduced soil stability by vegetation removal and reduced percolation increases surface runoff, resulting in flood conditions further downhill (DON 2001b).

4.2.6 Hydrology

A general discussion of O'ahu's hydrogeology is presented in Section 2.2.6. The discussion of the hydrology of the Lualualei INRMP Study Area is divided into two subsections: (1) surface water and (2) hydrogeology.

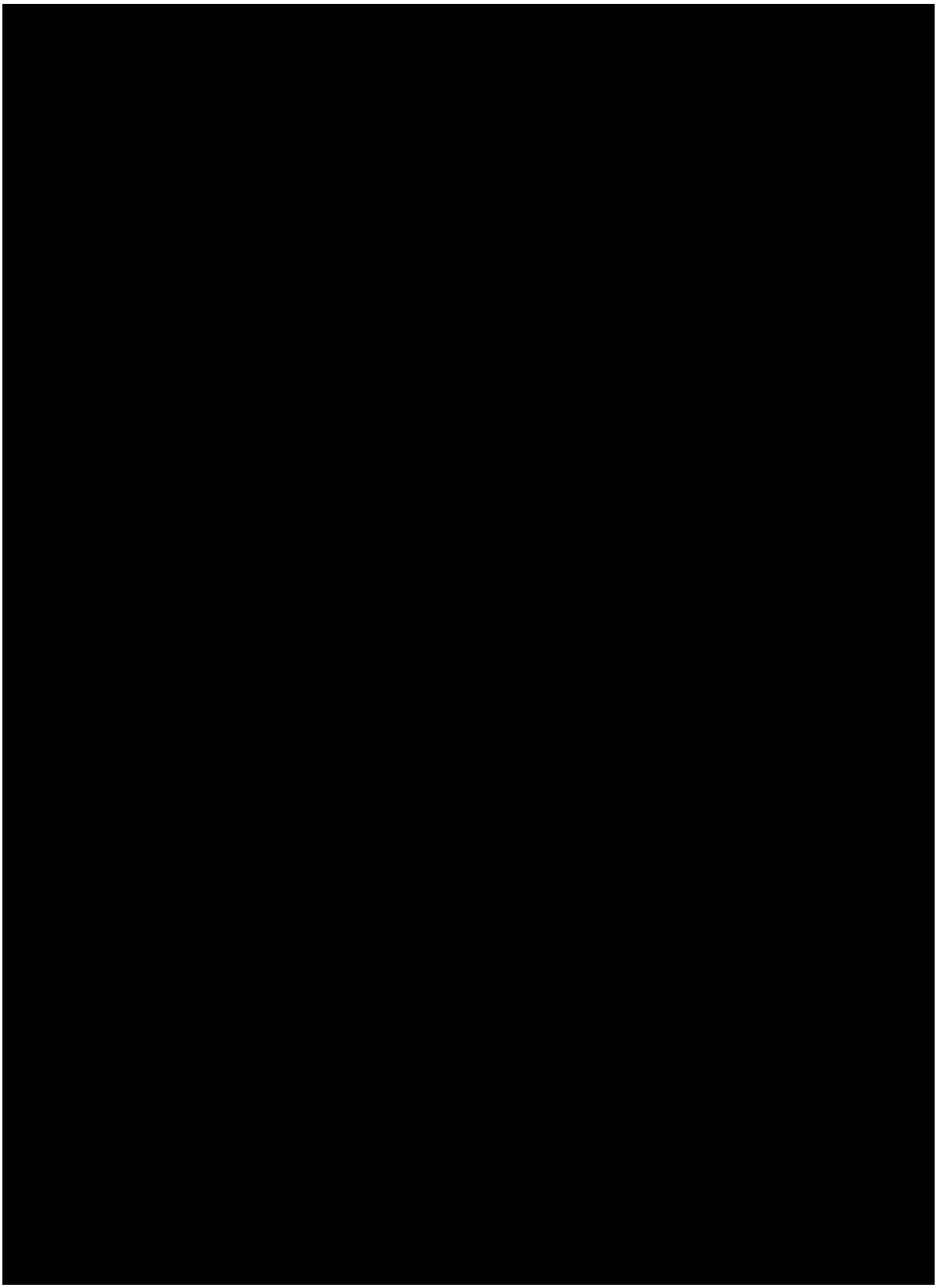

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Figure 4-4: Soils, Lualualei Study Area

Table 4-1: Soils, Lualualei Study Area

Soil Type	Location	Description	Characteristics
'Ewa Series: The 'Ewa Series consists of well-drained soils in basins and on alluvial fans. These soils developed in alluvium derived from basic igneous rock.			
'Ewa stony silty clay, 6 to 12 percent slopes (EwC)	This soil type occurs on alluvial fans and terraces.	In a representative profile the surface layer is dark reddish-brown silty stony clay about 18 in (46 cm) thick. The subsoil is about 42 in (107 cm) thick and is dark reddish-brown and dark-red silty clay loam that has subangular blocky structure. The substratum is coral limestone, sand, or gravelly alluvium. The soil is neutral in the surface layer and subsoil.	Permeability is moderate. Runoff is slow to medium and erosion hazard is slight to moderate. The available water capacity is about 1.3 in/ft (10.8 cm/m). This soil is more than 60 in (152 cm) deep.
'Ewa Silty clay loam, moderately shallow, 0 to 2 percent slopes (EmA)	This soil type occurs on alluvial fans and terraces.	This soil has a profile like EwC except that the depth to coral limestone is 20 to 50 in (51 to 127 cm).	Permeability is moderate. Runoff is very slow and the erosion hazard is mild. The available water capacity is about 1.3 in/ft (10.8 cm/m). This soil is more than 60 in (152 cm) deep.
Hale'iwa Series: The Hale'iwa series consists of well-drained soils on fans and in drainageways along the coastal plains. They developed in alluvium derived from basic igneous material.			
Hale'iwa silty clay, 0 to 2 percent slopes (HeA)	This soil type occurs as large areas on alluvial fans or as long narrow areas in drainage ways.	In a representative profile the surface layer is dark-brown silty clay about 17 in (43 cm) thick. The subsoil and substratum, to a depth of more than 5 ft (2 m), are dark brown and dark yellowish-brown silty clay that has subangular blocky structure. The soil is neutral to slightly acid.	Permeability is moderate. Runoff is very slow, and the erosion hazard is no more than slight. The available water capacity is about 1.9 in/ft (15.8 cm/m).
Hale'iwa silty clay, 2 to 6 percent slopes (HeB)	This soil type occurs as large areas on alluvial fans or as long narrow areas in drainage ways.	This soil type is similar to HeA.	This soil type is similar to HeA except that runoff is slow, and the erosion hazard is slight.
Lualualei Series: Lualualei Series consists of well-drained soils on the coastal plains, alluvial fans, and on talus slopes. These soils developed in alluvium and colluvium. They are nearly level and gently sloping.			

Table 4-1: Soils, Lualualei Study Area (Continued)

Soil Type	Location	Description	Characteristics
Lualualei clay, 0 to 2 percent slopes (LuA)	This soil type occurs on alluvial fans.	In a representative profile the surface layer, about 10 in (25 cm) thick, is very dark grayish brown, very sticky and very plastic clay that has prismatic structure. The next layer, 27 to more than 42 in (69 to 107 cm) thick, is a dark grayish-brown, very sticky, and very plastic clay that has prismatic structure. In addition, it has gypsum crystals. The soil is underlain by coral, gravel, sand, or clay at depths below 40 in (102 cm). It is neutral in the surface layer and medium acid to moderately alkaline in the underlying layers.	This soil cracks widely upon drying. Permeability is slow, runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.4 in/ft (11.7 cm/m). The very sticky and very plastic nature of the clay makes cultivation difficult and practical only within a narrow range of moisture content. Because of the high shrink and swell potential, considerable care is necessary when using this soil as a site for buildings or highways.
Lualualei clay, 2 to 6 percent slopes (LuB)	This soil type occurs on alluvial fans.	It is similar to LuA except for the slope.	The soil is similar to LuA except that runoff is slow and the erosion hazard is slight
Lualualei stony clay, 0 to 2 percent slopes (LvA)	This soil occurs on alluvial fans adjacent to drainage ways.	It is similar to LuA except that there are enough stones to hinder machine cultivation.	This soil is similar to LuA.
Lualualei stony clay, 2 to 6 percent slopes (LvB)	This soil occurs adjacent to drainageways.	It is similar to LuA except that there are enough stones to hinder machine cultivation.	This soil is similar to LUA except that runoff is slow and the erosion hazard is slight.
Lualualei extremely stony clay, 3 to 35 percent slopes (LPE).	This soil occurs on talus slopes.	This soil is similar to LuA except that there are many stones on the surface and in the profile. It is impractical to cultivate this soil unless the stones are removed.	This soil is similar to LuA except that runoff is medium to rapid, and the erosion hazard is moderate to severe.
Māmala Series: This series consists of shallow, well-drained soils along the coastal plains. These soils formed in alluvium deposited over coral limestone and consolidated calcareous sand.			
Māmala stony silty clay loam, 0 to 12 percent slopes (MnC)	These soils occur on coastal plains.	Neutral to mildly alkaline, dark reddish-brown stony silty clay loam in the surface layer (~ 8 in [20 cm] thick). The subsoil is neutral to mildly alkaline, dark reddish-brown silty clay loam (~11 in [28 cm] thick). The soil is underlain by coral limestone and consolidated calcareous sand at depths of 8 to 20 in (20 to 51 cm). Stones, mostly coral rock fragments, are common in the surface layer and in profile.	Permeability is moderate. Runoff is very slow to medium and the erosion hazard is slight to moderate. The available water capacity is 2.2 in/ft (18 cm/m) in the surface layer and 1.9 in/ft (16 cm/m) in the subsoil.

Table 4-1: Soils, Lualualei Study Area (Continued)

Soil Type	Location	Description	Characteristics
Pūlehu Series: This series consists of well-drained soils on alluvial fans and stream terraces and in basins. They developed in alluvium washed from basic igneous rock.			
Pūlehu clay loam, 0 to 3 percent slopes (PsA)	This soil is found on alluvial fans and stream terraces and in basins.	In a representative profile the surface layer is dark-brown clay about 21 in (53 cm) thick. This is underlain by dark-brown, dark grayish-brown, and brown massive loam and silt loam about 39 in (99 cm) thick. Below this is coarse, gravelly, or sandy alluvium. The soil is neutral in the surface layer and neutral to mildly alkaline below the surface layer.	Permeability is moderate. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.4 in/ft (11.6 cm/m) in the surface layer and subsoil.
P'lehu stony clay loam, 2 to 6 percent slopes (PuB)	This soil is found on alluvial fans and stream terraces and in basins.	This soil is similar to PsA except that on this soil, there are sufficient stones to hinder tillage but not enough to make intertilled crops impracticable.	This soil is similar to PsA except that runoff is slow, and the erosion hazard is slight to moderate. Workability is difficult because of the stones.
P'lehu very stony clay loam, 0 to 12 percent slopes (PvC)	This soil is found on alluvial fans and stream terraces and in basins.	This soil is similar to PsA except that as much as 3 percent of the surface is covered with stones.	This soil is similar to PsA except that runoff is slow to medium and the erosion hazard is slight to moderate. Workability is difficult because of the stones.
Rockland (rRK)	This soil type includes exposed rock covering 25 to 90 percent of the surface and can be found at Makalapa Crater and Red Hill Storage Area.	The rock outcrops and very shallow soils are the main characteristics. The rock outcrops are mainly basalt and andesite.	In many areas, the soil material associated with the rock outcrops is very sticky and very plastic. It also has high shrink-swell potential. Buildings on the steep slopes are susceptible to sliding when the soil is saturated. Foundations and retaining walls are susceptible to cracking.
Stony land (rST)	This soil type occurs in valleys and on side slopes of drainage ways.	It consists of a mass of boulders and stones deposited by water and gravity. Stones and boulders cover 15 to 90 percent of the surface. The soil among the stones consists of silty clay loam. In most places there is enough soil among the stones to provide a foothold for plants.	No characteristics were reported.
Tropohumults-Dystrandepts Association: Areas mapped as Tropohumults-Dystrandepts association consist of mountainous areas in the Wai'anae Range. Deep, V-shaped drainage ways and narrow ridges dominate the areas. Most of this association is very steep and inaccessible. It serves mainly as a watershed.			

Table 4-1: Soils, Lualualei Study Area (Continued)

Soil Type	Location	Description	Characteristics
Tropohumults-Dystrandepts Association (rTP)	Tropohumults occur on narrow ridge tops at the higher elevations. Dystrandepts occur on steep side slopes and narrow ridge tops at the lower elevations. These soils formed mainly in volcanic ash, but partly in colluvium. Histosols occupy small, wet positions near mountain peaks.	The soils in this association consist mainly of Tropohumults and Dystrandepts. Histosols make up a smaller part of the association. Tropohumults are well-drained, strongly acidic to extremely acidic soils. The surface layer consists of reddish-brown silty clay that has strong structure and high bulk density. The subsoil has strong subangular blocky structure; it is underlain by an ironstone pan or by saprolite. A hard crust that has a purplish cast forms on these soils in some places where the vegetation has been depleted. Dystrandepts are dark-colored, friable soils. In most places the surface layer is silty clay. The subsoil is generally massive. They are well drained and medium to strongly acidic. Histosols are poorly drained and have accumulations of organic materials as much as 3 ft (1 m) thick.	No characteristics were reported.

Source: USDA 1973; NRCS 2007

4.2.6.1 Surface Water Resources

There is one perennial stream located in the Lualualei INRMP Study Area. Pūhāwai Stream is located on the north-central portion of NAVMAG PH Lualualei (Figure 4-1). There were once streams in all five of the smaller valleys within Lualualei Valley (Perkins 1913 in DON 2001b). Many of these streams have since disappeared or are intermittent due to water diversions for agriculture and urban uses. Today, deep gulches throughout the upper portion of these valleys are present. NAVMAG PH Lualualei Branch lands drain toward the western boundary of the installation adjacent to NRTF Lualualei into a branch of Mā'ili'ili Stream, an intermittent stream emanating from the Wai'anae Mountain Range. The upper reaches of the stream are typical of many small Hawaiian watersheds with short, straight channels, steep gradients, and narrow stream bottoms, and thus are subject to flash flooding. The fans onto which storm water flow discharges are extremely stony and their black vertisols, once expanded, have low water intake rates. Adjacent to and south of the NRTF Lualualei is Ulehawa Stream which runs through NAVMAG PH Lualualei (DON 2001c).

There are no natural or permanent freshwater lakes, streams, or wetlands at NRTF Lualualei; however, there are two former stabilization and oxidation ponds (Niuli'i Ponds Wildlife Refuge) that serve the adjacent NAVMAG PH Lualualei Branch sewerage system, the downstream overflow reservoir, and Mā'ili'ili Stream (DON 2001c).

The stabilization and oxidation ponds (Niuli'i Ponds Wildlife Refuge) are entirely built facilities and dependent on the flow of stormwater runoff and wastewater effluent from NAVMAG PH Lualualei Branch and continuous groundwater pumping. See expanded discussion in Section 4.3.2. The pond areas are part of the wildlife refuge established by the Navy and have a total acreage of 9.6 ac (3.9 ha). However, with the transfer of personnel from NAVMAG PH Lualualei Branch in recent years, the majority of source water has been eliminated and the ponds have dried up. Standing water has been reduced to an area of approximately 1 ac (0.4 ha). Currently, source water for the ponds consists of minimal flows from NAVMAG PH Lualualei Branch. Any change in that flow may directly affect the water level in the ponds (DON 2001c).

4.2.6.2 Hydrogeology

Section 2.2.5 provides a summary of the four major aquifer types that occur on O'ahu. Groundwater resources beneath the Wai'anae Coast result from precipitation infiltrating the ground surface and percolating downward into permeable rock materials. Groundwater occurs in the upland Wai'anae Range basalt lava flows, the Lualualei Valley alluvium, the coralline deposits, and in the basaltic lava flows beneath the valley.

NAVMAG PH Lualualei Branch and NRTF Lualualei are located in the Lualualei Aquifer System of the Wai'anae Aquifer Sector. The eastern portion of NAVMAG PH Lualualei Branch, at higher elevations, is underlain by a high level, unconfined, dike-compartment aquifer that is currently used for drinking water. This aquifer is considered to be fresh with less than 250 mg/L Cl^-. It is considered irreplaceable with a high vulnerability to contamination (Mink and Lau 1990). The installation derives its drinking water from this aquifer which is fed by Pūhāwai Stream, located at the north end of the installation. The intermittent stream appears to flow from water percolating from dikes just above the base of Pu'ukū Makali'i. A large artificial aqueduct that connects to the base of the mountain is adjacent to Pūhāwai Stream and can be seen from Kolekole Road. Another water source is Pōhākea Spring, located in the southeast portion of the valley in the Hālona Subdistrict. This water source, however, is small in comparison to the Pūhāwai Stream water source, and water flowing from this spring often collects in a small reservoir or dissipates downstream (DON 2001b).

The majority of the western portion of the installation, at lower elevations, is largely underlain by a basal, unconfined, dike-compartment aquifer that has potential use. It has moderate salinity (1,000 to 5,000 mg/L Cl^-) and is considered replaceable. It has a high vulnerability to contamination. Two other aquifers (30302116 13311 and 30302122 23323) underlie the very western boundary of the installation. The first aquifer is classified as a basal, unconfined sedimentary aquifer that is currently used but is not used for drinking water nor is it ecologically important. This aquifer has moderate salinity (1,000 to 5,000 mg/l Cl^-), is irreplaceable and has a high vulnerability to contamination. The second aquifer is a basal, confined, dike aquifer. It has potential use; however, it would not be used for drinking water nor is it ecologically important. The aquifer has moderate salinity, is replaceable, and has a low vulnerability to contamination (Mink and Lau 1990).

4.3 GENERAL BIOTIC ENVIRONMENT

Information on biological resources presented in this and subsequent sections are primarily derived from surveys of terrestrial plants and terrestrial animals conducted as part of this INRMP update process and the 2001 INRMP (DON 2001b). The reports of the 2006 surveys for the Lualualei INRMP study area, listed below, are contained in the appendices.

- Lualualei Botanical Progress Report (NAVFAC PAC 2006e; Appendix C1)

- Flora and Fauna Survey of Naval Magazine Pearl Harbor, Lualualei Branch, Lualualei Valley, O'ahu, Hawai'i (HNHP 2004a; Appendix C2)
- A survey for *Alectryon macrococcus* var. *macrococcus* and *Flueggea neowawraea* in Lualualei Valley, Wai'anae Mountains, O'ahu, Hawai'i (HNHP 2003; Appendix C3)
- List of Plants at NAVMAG PH Lualualei and West Loch Branches (DON 2001b; Appendix C4)
- Flora and Fauna Survey of the Naval Computer and Telecommunications Area Master Station Pacific, O'ahu, Hawai'i (HNHP 2004b; Appendix D1)
- Plants of Naval Computer and Telecommunications Area Master Station Pacific (DON 2001c; Appendix D2)
- O'ahu 'Elepaio Surveys Naval Magazine, Lualualei Branch Hawai'i (NAVFAC PAC 2003e; Appendix C5)
- Naval Magazine Lualualei Arthropod Report (NAVFAC PAC 2007f; Appendix C6)
- Puhawai Falls Site Visit 15 August 2006 (NAVFAC PAC 2006f; Appendix C11)
- Puhawai Falls Site Visit 30August 2006 (NAVFAC PAC 2006l; Appendix C12)
- Puhawai Falls Site Visit 30 October 2006 (NAVFAC PAC 2006m; Appendix C13)
- Herpetological and Mammal Surveys on Navy Lands (NAVFAC PAC 2006d; Appendix A9)
- Snail Fauna of Lualualei (NAVMAG PAC 2007b; Appendix C6)
- List of Animals at NAVMAG PH Lualualei Branch (DON 2001b; Appendix C8)
- Report on Waterbirds Using Niuli'i Ponds within the Niuli'i Wildlife Refuge, O'ahu, Hawai'i (NAVFAC PAC 2006c; Appendix D3)
- List of Animals, Naval Computer Telecommunications Area Master Station Pacific (in DON 2001c; Appendix D4)

The discussion of the general biotic environment is divided into five subsections (4.3.1 through 4.3.5): (1) threatened and endangered species, candidate species, and species of concern; (2) wetlands; (3) ecosystems; (4) wildlife; and (5) vegetation.

4.3.1 Threatened, Endangered, and Candidate Species and Species of Concern

Federally protected plants and animals inhabit both NAVMAG PH Lualualei and NRTF Lualualei including four listed waterbird species, one listed forest bird species, one federally-listed snail species, 21 listed endangered plants, two candidate plant species, and six plant species of concern. In addition, critical habitat areas have been designated within the Lualualei INRMP Study Area for the O'ahu 'elepaio and 21 plant species (Figure 4-2). In addition, the Hawaiian short-eared owl, an SOH endangered species (O'ahu only) occurs within the study area. There are four SMAs (Figure 4-1). The discussion of protected species and habitats is divided into three subsections: (1) animals; (2) plants; and (3) SMAs.

Table 4-2: Federally- and SOH-Listed ESA Species, Candidate Species, and Species of Concern at Lualualei

Latin Binomial	Common Name	Regulatory Status
Animal Species		
Bird Species		
Anas wyvilliana	Hawaiian Duck	E
Gallinula chloropus sandviciensis	Hawaiian Common Moorhen	E

Table 4-2: Federally- and SOH-Listed ESA Species, Candidate Species, and Species of Concern at Lualualei (Continued)

Latin Binomial	Common Name	Regulatory Status
Himantopus mexicanus knudseni	Hawaiian Stilt	E
Fulica alai	Hawaiian Coot	E
Chasiempis sandwichensis ibidis	O'ahu 'Elepaio	E, last observed 2008, CH
Asio flammeus sandwichensis	Hawaiian short-eared Owl	E (SOH only)
Mammal Species		
Lasiurus cinereus semotus	Hawaiian Hoary Bat	E, probable
Snail Species		
Achatinella mustelina	O'ahu Tree Snail	E
Amastra cyclindrica	NCN	None, but critically rare, potential for listing
Arthropod Species		
Drosophila spp.	Hawaiian Picture Wing Flies	Not listed, species observed, but discussion needed
Hylaeus spp.	Hawaiian Yellow-faced Bees	Not listed, species observed, but discussion needed
Megalagrion spp	Hawaiian Damselflies	Not listed, species observed, but discussion needed
Plant Species		
Abutilon menziesii	NCN	E, CH (no data on CH acreage)
Abutilon sandwicense	NCN	E, CH (81 ac/33 ha CH)
Alectryon macrococcus	Māhoe	E, last observed 2004
Bobea sandwicensis	'Ahakea	SOC
Bonamia menziesii	NCN	E
Chamaesyce kuwaleana	'Akoko	E, CH (268 ac/108 ha CH)
Cyanea calycina	Hāhā	Candidate
Cyperus trachysanthos	NCN	E, CH (no data on CH acreage)
Diellia falcata	NCN	E, unoccupied CH (97 ac/39 ha CH)
Diellia unisora	NCN	E, CH (278 ac/113 ha CH)
Flueggea neowawraea	Mēhamehame	E
Gouania meyenii	NCN	E, unoccupied CH (7 ac/3 ha CH)
Kadua (was Hedyotis) parvula	NCN	E, CH (325 ac/132 ha CH)
Labordia kaalae	NCN	SOC
Lepidium arbuscula	NCN	E, CH (515 ac/208 ha CH)
Lipochaeta lobata var. leptophylla	Nehe	E, CH (1,194 ac/483 ha CH)
Lobelia niihauensis	NCN	E
Lobelia yuccoides	NCN	SOC
Marsilea villosa Kaulf.	'Ihi'ihi	E, CH (169 ac/68 ha CH)

Table 4-2: Federally- and SOH-Listed ESA Species, Candidate Species, and Species of Concern at Lualualei (Continued)

Latin Binomial	Common Name	Regulatory Status
Melanthera tenuis	NCN	SOC
Melicope christophersenii	Alani	Candidate
Melicope pallida	Alani	E, unoccupied CH (122 ac/49 ha CH)
Melicope saint-johnii	Alani	E, unoccupied CH (169 ac/68 ha CH)
Neraudia angulata var. angulata	NCN	E, CH (207 ac/84 ha CH)
Neraudia angulata var. dentate	NCN	E, CH
Neraudia melastomifolia	NCN	SOC
Nototrichium humile	Kulu'ī	E
Plantago princeps var. princeps	Laukahi Kuahiwi	E
Platydesma cornuta var. decurrens	NCN	Candidate
Pleomele forbesii	Hala pepe	Candidate
Sanicula mariversa	NCN	E, unoccupied CH (81 ac/33 ha CH)
Schiedea hookeri	NCN	E, CH (238 ac/96 ha CH)
Schiedea pentandra	NCN	SOC
Silene perlmanii	NCN	E, unoccupied CH (285 ac/115 ha CH)
Spermolepis hawaiiensis	NCN	E
Tetramolopium filiforme Sherff	NCN	E
Tetramalopium lepidotum ssp. lepidotum	NCN	E, unoccupied CH
Urera kaalae	NCN	E. unoccupied CH
Viola chamissoniana ssp. chamissoniana	Pāmakani	E, CH

NCN – no common name, E=endangerd; SOH=State of Hawaii; CH=critical habitat; SOC = species of concern

4.3.1.1 Animals

1. NAVMAG PH Lualualei Branch

Two federally-listed endangered animal species and one SOH-listed endangered animal species inhabit NAVMAG PH Lualualei Branch: (1) O'ahu tree snail (*Achatinella mustelina*); (2) O'ahu 'elepaio (*Chasiempis sandwichensis ibidis*); and (3) Hawaiian short-eared owl (HNHP 2004a). These species are discussed in the following paragraphs and mapped locations are shown on Figure 4-5. In addition, the very rare snail, *Amastra cylindrica*, was found within the installation. Also, the federally-listed Hawaiian hoary bat (*Lasiurus cinereus semotus*) probably occurs at NAVMAG PH Lualualei.

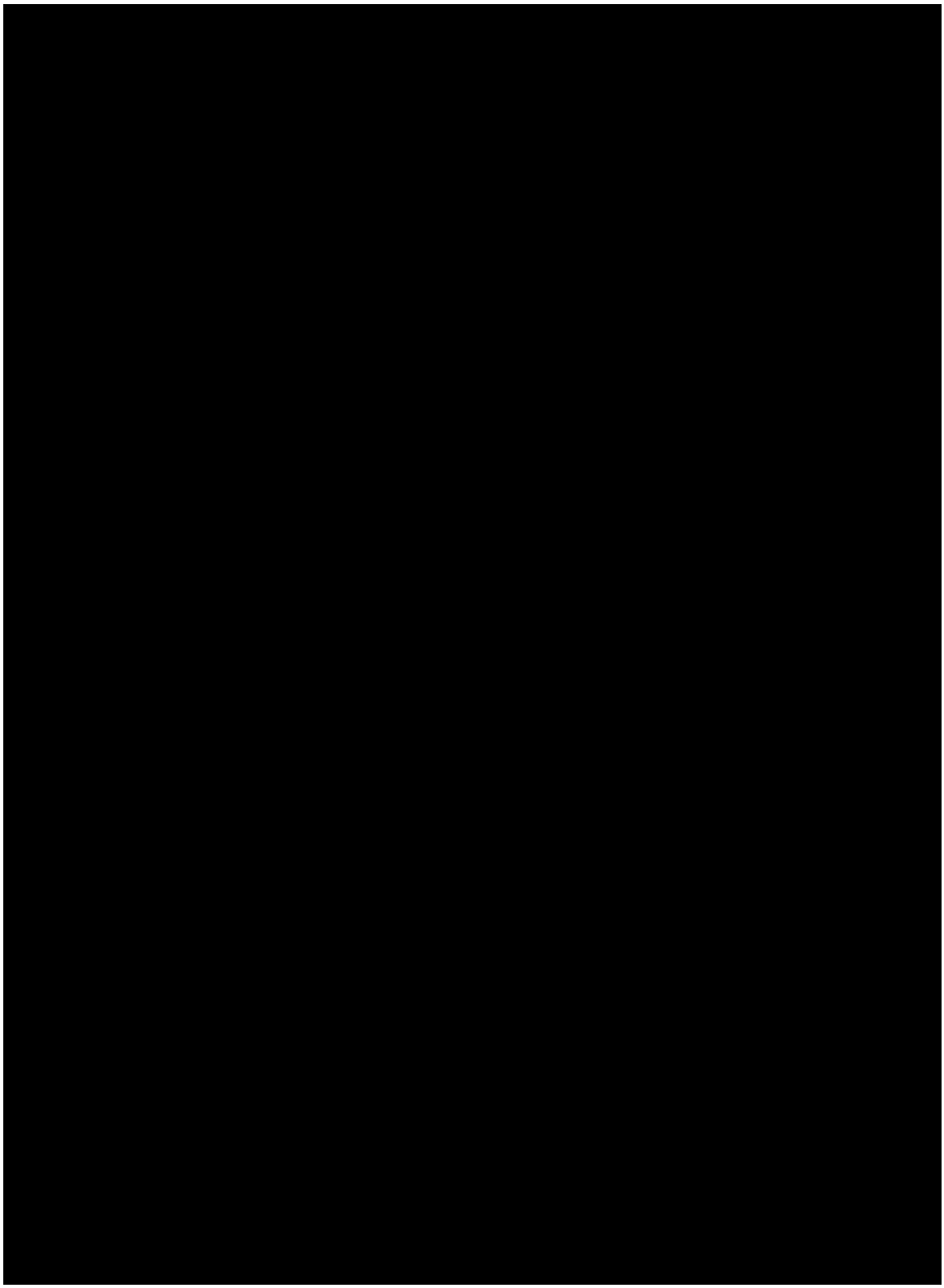

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Figure 4-5: Federally- and SOH-listed Animal Species, Federal Candidate Animal Species, and Animal Species of Concern Mapped at the Lualualei Study Area

Photograph 4-4: O'ahu tree snail

O'ahu tree snail. The O'ahu tree snail (Photo 4-4) is a federally-listed, endangered, endemic tree snail. The snail is historically documented within NAVMAG PH Lualualei Branch and was found in the Pu'u Hāpapa area (Figure 4-5), south of Kolekole Pass, and Pu'ukū Makali'i, north of Kolekole Pass. This species is found in the mesic forests on the ridges of the eastern border of Lualualei Valley primarily in native trees. It is believed that O'ahu tree snails are a historic occurrence in the Lualualei Valley floor, but now they have been found only at various high elevations along the Wai'anae summit ridge. Primary threats to the endangered snails' existence include habitat loss, predation, and over-collection (HNHP 2004a).

Survey results from Lualualei Valley indicate that there are no *A. mustellina* at intermediate to low levels within the valley. The endangered snail has been found only at various high elevation locations along the Wai'anae summit ridge. Two of those locations fall within the boundaries of NAVMAG PH Lualualei: Pu'u Hāpapa and Pu'ukū Makalii (NAVFAC PAC 2007b).

The greatest threats to populations of *A. mustellina* at Pu'u Hāpapa are predation from rodents and habitat degradation from invasive weeds. The survey report recommended funding and implementation of a long–term predator control program at Pu'u Hāpapa. Additionally, it was recommended to continue periodic monitoring of *A. mustellina* populations and habitat quality and adjust the predator control program or conduct habitat improvements as necessary (NAVFAC PAC 2007b).

***Amastra cylindrica*.** *Amastra cylindrica* is extremely rare but is not currently listed or a candidate species. It was thought to be extinct up until 1995 when it was discovered in a small area measuring approximately 45 ft (15 m) by 45 ft (15 m), dominated by a few large trees – *Pisonia umbellifra,* and within a hanging gulch on NAVMAG PH Lualualei of Pu'u Hāpapa. Currently, this species is not known to occur anywhere else outside of this area. *A. cylindrica* is being considered for inclusion on the endangered species list (NAVFAC PAC 2007b). Surveys conducted by NAVFAC PAC in 2006 of the same site confirmed that the population of *A. cylindrica* is still viable but, perhaps, less plentiful. The site was under increasing pressure from invasive weeds and there is evidence of predation of *A. cylindrica* from rats and *Euglandina rosea,* another snail. The snails that were found in 2006 were juveniles, providing additional evidence that larger adult snails may be under severe pressure from predation by rodents (NAVFAC PAC 2007b).

Photograph 4-5: *Amastra cylindrica*

The greatest threats to populations of *A. mustellina* at Pu'u Hāpapa are predation from introduced carnivorous snails (*Euglandina rosea*) and rodents, and habitat degradation from invasive weeds. These threats are particularly severe to *A. cylindrica* due to the fact that Pu'u Hāpapa is the only location of an extant population for this species. The survey report recommended funding and implementation of a long–term predator control program at Pu'u Hāpapa. Additionally, it was recommended to continue periodic monitoring *A. cylindrica*

populations and habitat quality and adjust the predator control program or conduct habitat improvements as necessary (NAVFAC PAC 2007b).

The Navy has funded a predator control program at Pu'u Hāpapa and has provided additional funds for snail monitoring and habitat improvement. Baiting and trapping of rodents at Pu'u Hāpapa was initiated in March 2007 and is currently ongoing. NAVFAC PAC biologists continue to monitor the population of *A. cylindrica* and provide control of invasive weeds in the area (NAVFAC PAC 2007b). Snail counts are conducted at least once a year, with the most recent occurring on 16 August 2010. After a one hour period of searching by one biologist, three adults and one juvenile living *A. cyldindrica* and five recently emptied juvenile *A. cyldindrica* shells were found in the rocks. The empty shells showed no evidence of rodent predation and were entirely intact. Predatory invertebrates at the sight included one *E. rosea* and flatworms (approximately four to six, identification uncertain).

O'ahu 'Elepaio. The O'ahu 'elepaio (Photo 4-6) is a federally-listed, endemic, monarch flycatcher (bird species). Once widespread, these birds now are thought to occupy less than four percent of their original range. Formerly, these birds were found in a variety of forest types at all elevations of the island, but are now only found in mid-elevation forests in portions of the Ko'olau and Wai'anae Mountains. Within these forests, they are found mostly in habitat along stream beds that support trees offering a tall canopy, with lower vegetation providing a well-developed understory. O'ahu 'elepaio has adapted relatively well to disturbed forests dominated by introduced plants. The reasons for the O'ahu 'elepaio decline include disease (predominantly avian pox and malaria) and predation of eggs, nestlings, and incubating females by introduced mammals, especially rats. Critical habitat designation recognizes five distinct units of critical habitat for the O'ahu 'elepaio totaling 65,879 ac (26,661 ha). Portions of Units 1 and 2, Northern Wai'anae Mountains and Southern Wai'anae Mountains, respectively, totaling 1,695 ac (686 ha), are located on installation lands (Figure 4-2). The O'ahu 'elepaio has been observed in two locations within Lualualei Valley: (1) Kauhiuhi subdivision of the north facing slopes of Pu'u Kaua; and (2) pocket pāpala kēpau (*Pisonia* sp.) forest in the Pu'u Hāpapa SMA upper unit. In addition, the birds have also been observed on the high-altitude ridgeline on the eastern border of the installation (NAVFAC PAC 2003e).

Photograph 4-6: O'ahu 'elepaio

The Navy orchestrated past surveys for the ESA-protected O'ahu 'elepaio in order to proactively manage this species (NAVFAC PAC 2003e, HNHP 2004a, NAVFAC PAC unpublished data). Population levels were critically low as of 2003, with only five individuals detected within the study area located in the Kauhiuhi subdistrict of Lualualei (NAVFAC PAC 2003e). In 2004, between four and six individuals were detected (HNHP 2004a). Surveys were again conducted in 2005, when four individuals were detected, and in 2006, when just two individuals were detected (NAVFAC PAC unpublished data). The last complete survey for 'elepaio across all known 'elepaio territories in NAVMAG PH Lualualei was conducted during the 2007 breeding season. No 'elepaio were detected at this time (NAVFAC PAC unpublished data). It is likely that a combination of factors, including habitat loss, competition from non-native birds, mosquito-borne avian disease, and predation from introduced mammalian predators has contributed to the decline of this species at NAVMAG PH Lualualei.

The most commonly seen native plant species observed in areas where 'elepaio were recorded were kaulu (*Sapindus oahuensis*), alahe'e (*Psydrax odorata*), olopua (*Nestegis sandwichensis*), and pāpala (*Charpentiera obovata*). The most commonly observed introduced plants are kukui (*Aleurites moluccana*), Australian red cedar (*Toona ciliata)*, Christmas berry (*Schinus terebinthifolius*), and ti (*Cordyline terminalis*). The areas where 'elepaio were observed are dominated by introduced plant species, indicating that these birds can survive in sub-optimal habitat.

Hawaiian Short-eared Owl. The Hawaiian short-eared owl is a SOH-listed (on O'ahu) endangered bird species that is occasionally found within NAVMAG PH Lualualei Branch. It is has been observed flying above the ridges and slopes in Lualualei Valley and a nest with two eggs was observed on the ridge south of Pōhākea Pass, east of the installation boundary. Section 3.3.1.1 provides a short description of this species.

Hawaiian hoary bat: The federally-listed endangered and endemic Hawaiian hoary bat (Photo 4-7) probably occurs at NAVMAG PH Lualualei. The Hawaiian hoary bat is Hawai'i's only native terrestrial mammal. Males and females have a wingspan of approximately 1 ft (0.3 m) and have a coat of brown and gray fur. They roost in native and non-native vegetation from 3-29 ft (1 – 9 m) above ground level. They begin foraging either just before or after sunset and feed on a variety of native and non-native, night-flying insects including moths, beetles, crickets, mosquitoes, and termites. Coastlines and forest/pasture boundaries appear to be important foraging areas. Mating most likely occurs between September and December, and females give birth to twins between June and August. Mother bats likely stay with their pups until they are six to seven weeks old. Habitat loss, pesticides, predation, and roost disturbance affect bats. A reduction in tree cover (e.g. roost sites) might be the primary reason for the species' decline in Hawai'i (DOFAW 2005).

Photo 4-7: Hawaiian hoary bat

2. NRTF LLL

Four federally-listed endangered, endemic (i.e., found nowhere else in the world) waterbird species occur within the Niuli'i Ponds on NRTF Lualualei (Figure 4-5): (1) Hawaiian black-necked stilt; (2) Hawaiian common moorhen; (3) Hawaiian coot; and (4) Hawaiian duck. However, the ducks identified as Hawaiian ducks are probably hybrid mallard-Hawaiian duck (Section 4.3.4). One SOH-listed endangered (on O'ahu), endemic bird, the Hawaiian short-eared owl, may occur at NRTF Lualualei (HNHP 2004b). Section 3.3.1.1 provides a description of these bird species. The following paragraphs describe observations at Lualualei from the 2006 survey regarding the Hawaiian common moorhen, Hawaiian coot, and Hawaiian black-necked stilt. Hawaiian hoary bats probably occur at NRTF Lualualei.

Hawaiian common moorhen. The 2006 report on waterbirds using Niuli'i Ponds noted that the moorhen prefer habitats with dense vegetation to forage in and water depths less than 3.3 feet (1m). With the increase in water in 2006, moorhen have been increasingly observed along the edges of the water and along the dirt road that encircles the pond. They have also been observed foraging on the outside of the fence and along the fenceline. The greatest average

number observed at any one time was in August 2004 (34 adults, 14 sub-adults) when there was a small amount of water within the pond area, dense vegetation, and a greater amount of protected area (within the fenceline) to forage in than at the present. During 2005, with the increased water levels, average adult moorhen numbers ranged from three to 22 during all months surveyed; average subadult numbers ranged from one to six for the months January through October with a peak in June (NAVFAC PAC 2006c).

Hawaiian coot. The 2006 report on waterbirds using Niuli'i Ponds noted that the average number of coots ranged from zero to 10 from October 2002 to September 2003. The greatest number of coots were observed during the winter (or wetter) months (October 2002-April 2003) and were very low in numbers in the summer. No coots were observed when there was little or no water in August and September 2003. Average coot adult and sub-adult numbers also peaked in August 2004 (25 adults, 9 sub-adults) and then were not observed during November and December (NAVFAC PAC 2006c).

In January 2005, there was an increase of water in the area and for the rest of the year the average number of adult coots ranged from five to 100. The sub-adults were observed April through December 2005 and their average numbers ranged from one to 27. Coots have responded to the increase in open water at the refuge; many more forage, nest and raise broods when water levels are higher (NAVFAC PAC 2006c).

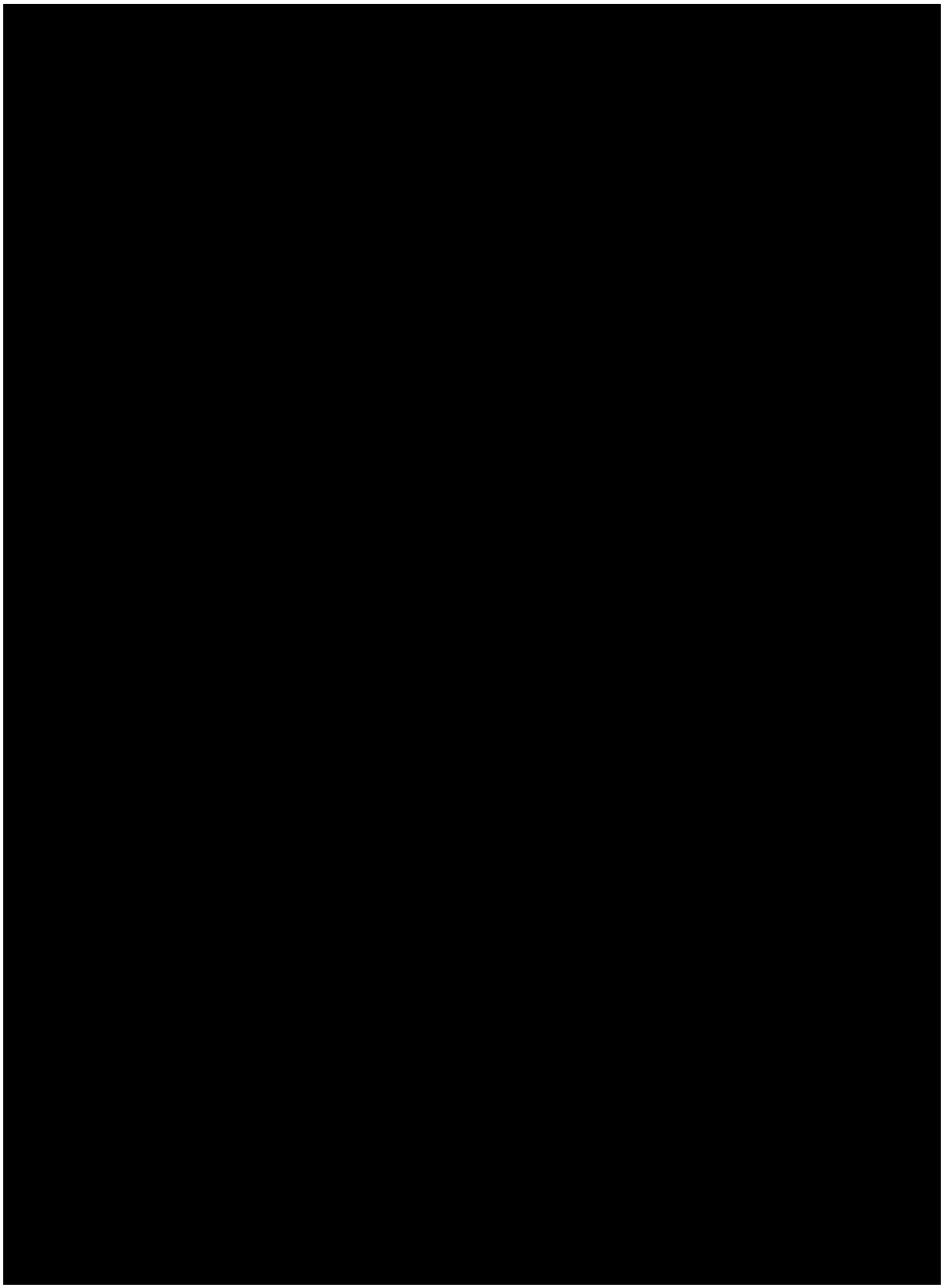
Hawaiian black-necked stilt. The 2006 report on waterbirds using Niuli'i Ponds noted that Hawaiian black-necked stilts were commonly observed from December 2002-July 2003. Their average numbers ranged from zero to six. In April and May, stilts were observed exhibiting nesting behavior, and in June, five juvenile stilts were observed. When there was little to no water in August and September 2003, stilts were not observed at the refuge. Hawaiian black-necked stilts were recorded only in January and August of 2004, but this may be due to the fact that no surveys were conducted from February through July. In general, the occupancy of the ponds by stilts increased in 2005. They were observed every month from January through October, and the average number ranged from two to 12. Nesting-type behavior was observed in April, but it is suspected that nesting did not occur due to a rookery of cattle egrets literally looming over the adults (NAVFAC PAC 2006c).

Duck (Hawaiian duck-mallard hybrid). The 2006 report on waterbirds using Niuli'i Ponds noted that the average number of ducks (presumed to be Hawaiian duck-mallard hybrids) observed from October 2002 through September 2003 was one or two ducks observed in most months and a maximum of three ducks observed in December and March. The number of ducks observed in 2004 remained approximately the same as in 2003. In 2005, numbers observed, in general, increased and ranged from two to 16 with ducklings observed in February and April (NAVFAC PAC 2006c).

4.3.1.2 Plants

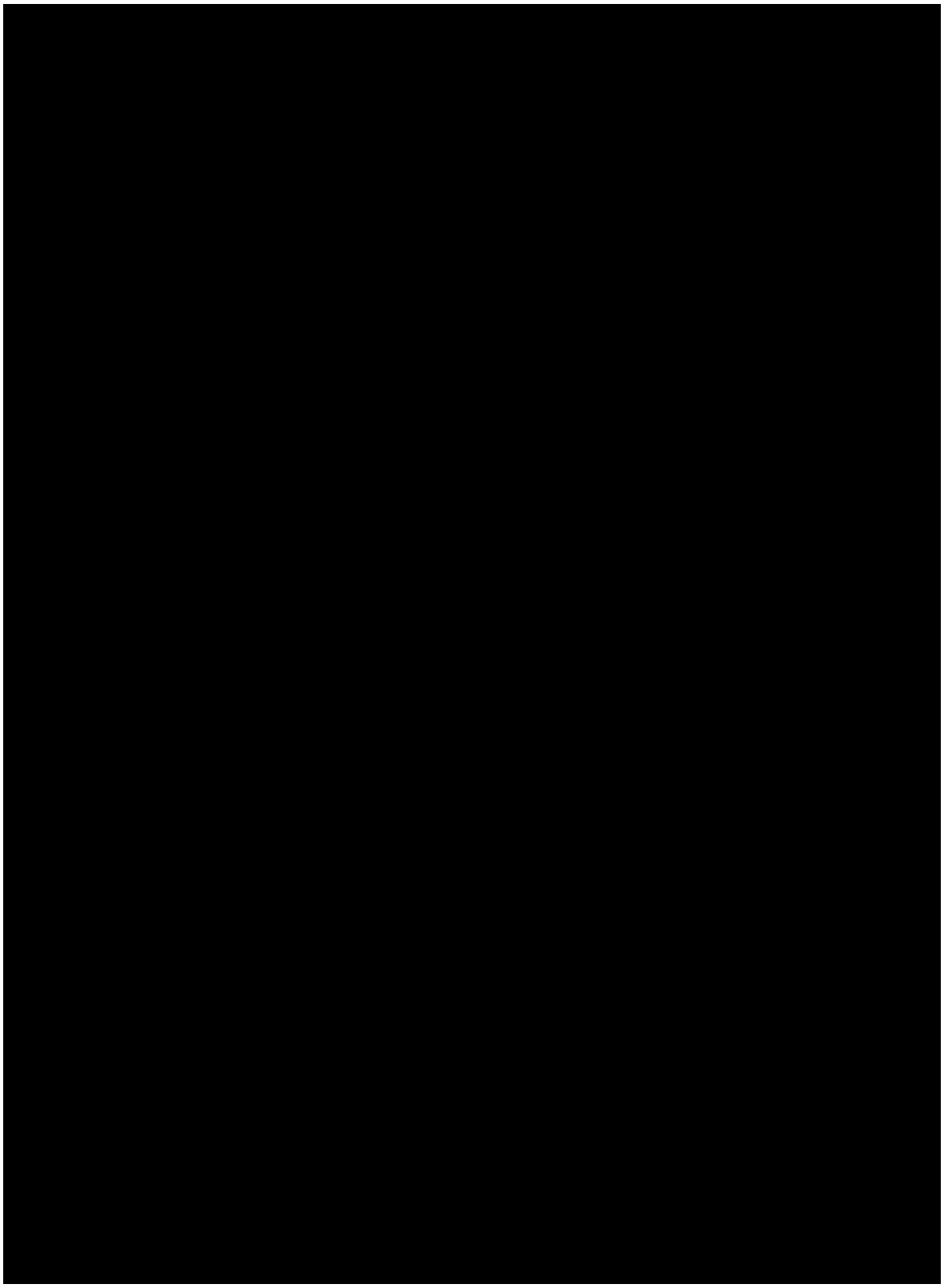
Table 4-3 presents a summary of the 21 federally-listed endangered plant species, two federal candidate species, and six federal species of concern that occur at the Lualualei INRMP Study Area. Figure 4-2 shows the critical habitat for the federally-listed plant species and Figures 4-6 and 4-7 present the distribution of federally-listed endangered plant species, and federal candidate species and federal species of concern, respectively.

Critical habitat has been designated for 21 plant species within the Lualualei INRMP Study Area (Figure 4-2 and Table 4-2). Thirteen of those plant species have been recorded in the study area: (1) *Abutilon menziesii*); (2) *Abutilon sandwicense*; (3) *Chamaesyce kuwaleana*; (4)



Redaction:Defense Critical Security Information Statute 10 U.S.C. § 130e

Figure 4-6: Federally-listed Plant Species Mapped at the Lualualei Study Area



Redaction:Defense Critical Security Information Statute 10 U.S.C. § 130e

Figure 4-7: Federal Candidate Plant Species and Species of Concern Mapped at the Lualualei Study Area

Cypersus trachysanthos; (5) *Diellia unisora*; (6) *Hedyotis parvula*; (7) *Lepidium arbuscula* (; (8) *Lipochaeta lobata var. leptophylla*; (9) *Marsilea villosa*; (10) *Neraudia angulata var. angulata*; (11) *Neraudia angulata var. dentate*; (12) *Schiedea hookeri*; (13) *Viola chamissoniana* ssp. *chamissonian*. The remaining eight species have not been recorded in the study area and are considered unoccupied portions of critical habitat: (1) *Diellia falcata*; (2) *Gouania meyenii*; (3) *Melicope saint-johnii*; (4) *Melicope pallida*; (5) *Sanicula mariversa*; (6) *Silene perlmanii*; (7) *Tetramolopium lepidotum* ssp. *Lepidotum*; and (8) *Urera kaalae.*

1. NAVMAG PH Lualualei Branch

There are 21 federally-listed endangered plant species, two federal candidate species, and six federal species of concern that occur at NAVMAG PH Lualualei (Table 4-3). In addition to the protected plant species, there is a small population of the rare coast sandalwood or 'iliahialo'e (*Santalum ellipticum*) located east of the end of Dent Street and on a small ridge above 59th Street. Both populations are mixed vegetation dominated by alien species. This species was not harvested much during the sandalwood trade (early 1800s); nonetheless, because its habitat has been displaced with more aggressive alien species (e.g. koa haole, grasses), coast sandalwood is becoming increasingly rare (DON 2001b).

A survey of the federally-listed endangered plant species *Alectryon macrococcus* var. *macrococcus* and *Flueggea neowawraea* in Lualualei Valley was conducted by HNHP in 2003. The survey report noted that *A. macrococcus* var. *macrococcus* trees were not observed during the survey, and no previously unrecorded *F. nowawraea* were found. However, significant new information was obtained regarding the sex and reproductive capacity of two of the known trees of *F. neowawraea*. Both trees were found to be female with one of them fruiting sparingly and the other profusely (HNHP 2003).

The survey noted that if any *A. macrococcus var. macrococcus* remain in the Lualualei INRMP Study Area, they are relatively unimportant with respect to the conservation of the taxon as a whole in the Wai'anae Mountains since there are relatively large populations elsewhere in the mountain range growing in habitat more favorable for the taxon than the habitat within the installation. In any case, there would be little that could be done to halt their decline as long as the black twig borer remains a serious threat to their survival. Conservation efforts would be best directed towards other rare plant taxa in NAVMAG PH Lualualei (HNHP 2003).

With regard to *F. neowawraea*, the survey report noted that action must be taken soon to ensure the preservation of whatever genetic variability the NAVMAG PH Lualualei trees might contribute in the conservation of the species as a whole. The Army has already begun implementing a genetic diversity preservation plan for the species throughout its range in Hawaii, and efforts on the part of the NAVFAC PAC with respect to the installation's trees would help in achieving the goals of this plan. Propagation of the Navy's trees that are on the verge of dying is especially urgent. In addition, alien trees observed crowding out the *F. neowawraea* should be gradually trimmed away and its response monitored (HNHP 2003).

The survey report noted that NAVMAG PH Lualualei contains some of the best remaining examples of *Sapindus oahuensis* dry forests. Throughout the Wai'anae Mountains, the forest type once supported fairly large numbers of *F. neowawraea*. The survey report recommended that the perpetuation of this forest type in NAVMAG PH Lualualei through active management as a valuable way ensure the long-term survival of *F. neowawraea* when outplanting of the species becomes possible (HNHP 2003).

Table 4-3: Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at the Lualualei INRMP Study Area

Hawaiian Name	Photograph/Latin Binomial	Common Name	Comments
Status: Federally-listed ESA Species (Endangered)			
Not available	 Photo 4-8: *Abutilon menziesii*	No common name (NCN)	*A. menziesii* (Photo 4-8) is a diffusely branched shrub in the mallow family that grows up to 4 to 7 ft (2 to 3 m) with light green, heart-shaped leaves with serrated edges. When in bloom, *A. menziesii* produces small (0.8 to 1.6 in [2 to 4 cm]) flowers that hang upside down. The color of the flowers differs from population to population from maroon to pale yellow and red. The flowers of the plant at NRTF Lualualei are pale yellow on the inside and red on the outside edges of the petals. The habitat for the *A. menziesii* includes dry coastal and lowland areas. The plants at Lualualei are the only wild *A. menziesii* plant discovered thus far on O'ahu aside from plants in the 'Ewa Plains area, and its genetic material may be important for the conservation of the O'ahu population of the species. A. menziesii occurs in one population within NRTF Lualualei and two in NAVMAG PH Lualualei. All individuals have been tagged. One population (ABUMEN-LLL-1) has been monitored for years and the other two populations were first observed in 2005. All three populations are found in sparse kiawe forest, with buffelgrass as the predominant ground cover. They generally seed throughout the year.

Table 4-3: Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch (Continued)

Hawaiian Name	Photograph/Latin Binomial	Common Name	Comments
Not available	 Photo 4-9: *Abutilon sandwicense (Degener Christoph)*	NCN	*Abutilon sandwicense (Degener Christoph)* (Photo 4-9) is a member of the mallow family. Endemic to dry forests of Wai'anae Mountains, this shrub is 5 to 20 ft (1.5 to 6.0 m) tall. Its leaves are heart-shaped and 3 to 9 in (8 to 22 cm) long. The flowers are solitary in the leaf axils, and pendulous. The narrow petals of the flower are green to reddish brown and 1.5 to 2 in (4 to 5 cm) long. Its fruit is vase-like and 0.7 in to 1 in (17 to 25 mm) long. Critical habitat is present at NAVMAG PH Lualualei (Figure 4-2). Plants were observed at Mikiula and Hālona Sites (Figure 4-6) in 2004.
ala'alahua, māhoe	 Photo 4-10: *Alectryon macrococcus Radlk. var. macrococcus*	NCN	*Alectryon macrococcus Radlk. var. macrococcus* (Photo 4-10) is a member of the soapberry family. Endemic. *A. macrococcus* var. *macrococcus* is a tree 10 to 37 ft (3 to 11 m) tall. Its compound leaves are 8 to 22 in (20 to 55 cm) long, with two to five pairs of leaflets. Its small flowers are either perfect (containing both male and female parts) or staminate (containing only male parts) and born in panicles up to 12 in (30 cm) long. The fruit is subglobose, and 1 to 3 in (2.5 to 7.0 cm) in diameter. The flesh of the fruit is scarlet and is enclosed within a hard rind. A tree was observed at Pu'u Kaua in 2004 and trees were observed at Pu'u Hāpapa in 1994 (within NAVMAG PH Lualualei Branch); they were not seen in 2004.

Table 4-3: Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch (Continued)

Hawaiian Name	Photograph/Latin Binomial	Common Name	Comments
Not available	 Photo 4-11*: Bonamia menziesii A. Gray*	NCN	*Bonamia menziesii A. Gray* (Photo 4-11) is a member of the morning glory family. Endemic to dry to mesic forests, rarely wet forests. *B. menziesii* is a vine with twinning stems up to 33 to 49 ft (10 to 15 m) long. The leaves are oblong-elliptic, ovate to rarely orbicular, and 1 to 4 inn (3 to 9 cm) long and 0.4 to 1.6 (1 to 4 cm) wide. The upper surface of the leaves may be smooth or covered with short wooly hairs, while the lower surface is almost always densely covered with yellowish-brown hairs. The flowers are solitary or sometimes cymes. The corollas are white to greenish-white and are 0.8 to 0.9 in (20 to 25 mm) long and 0.6 to 0.8 in (15 to 20 mm) wide. Plants were observed at Mikiula site (within NAVMAG PH Lualualei Branch) (Figure 4-6) in 2002 and 2003 by Navy staff.
ʻakoko, koko, ēkoko, kōkōmālei	 Photo 4-12*: Chamaesyce kuwaleana (Degener & Sherff) Deg. & I. Deg*	NCN	ʻAkoko (Photo 4-12) is a member of the spurge family. Endemic, primarily to Lualualei-Waiʻanae Kai. Found on dry to mesic ridges and cliffs. *C. kuwaleana* is a shrub that grows 0.7 to 3.0 ft (0.2 to 0.9 m) tall. The oppositely arranged leaves are 0.4 to 0.9 in (11 to 25 mm) long and 0.3 to 0.6 in (8 to 15 mm) wide and are ovate or rarely orbicular. The flowers are borne in cyathia (specialized infloresces) arranged singly in the learf axils or rarely at the tips of branches. The size and shape of the capsules are not known. In 2004, plants on Kauaopuu (within NAVMAG PH Lualualei Branch) appeared to be less common than in 1994. Some plants appeared to be defoliated by caterpillars. A fire occurred in this area in 2004.

Table 4-3: Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch (Continued)

Hawaiian Name	Photograph/Latin Binomial	Common Name	Comments
Not available	 Photo 4-13: *Cyperus trachysanthos*	NCN	*Cyperus trachysanthos* (Photo 4-13) is dispersed in three small populations within antenna fields at NRTF Lualualei (Figure 4-6). This plant species habitat is specialized requiring periodic flooding and drying to emerge, reproduce, and thrive. *C. trachysanthos* is found in low spots, ephemeral streams, and seasonal wetlands. In many areas, *C. trachysanthos* only emerges after a significant rain event. This plant species is known to stay dormant for many years. Federal regulations require that those habitat conditions cannot be modified without consultation under ESA. Two of the populations were first observed during the 2004 botanical survey (HNHP 2004b) and the third in 2006 by Navy landscaping staff.
Not available	 Photo 4-14: *Diellia unisora* W.H. Wagner	NCN	*Diellia unisora* W.H. Wagner (Photo 4-14) is a member of the spleenwort family. Endemic to the southern Waiʻanae Mountains. Grows in mesic grasslands, shrublands, or forests. *D. unisora* grows from a slender, erect rhizome 0.20 to 1.8 in (0.5 to 3.0 cm) tall and 0.16 to 0.40 in (0.4 to 1.0 cm) in diameter. The stipes are black and shiny. The rhizome and stipe bases are clothed with small jet-black scales. The fronds have 20 to 35 pairs of pinnae, and are linear, gradually narrowing towards the apex. The pinnae are usually strongly asymmetrical in outline. A single marginal sorus runs along the anterior edge of each pinna. Solitary individual plants were noted at the Waiʻanae summit ridge between Pōhākea Pass and Palikea in Hālona (within NAVMAG PH Lualualei Branch).

Table 4-3: Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch (Continued)

Hawaiian Name	Photograph/Latin Binomial	Common Name	Comments
mēhamehame	 *Photo 4-15: Flueggea neowawraea W. Hayden* Photo HIN	NCN	Mēhamehame (Photo 4-15) is a member of the spurge family. Found in mesic forests. *F. neowawraea* is dioecious (the male and female flowers are on separate plants). It is a tree up to 98 ft (30 m) tall, with a trunk up to7 ft (2 m) in diameters. Its leaves are ovate-elliptic, 2 to 6 in (4 to 14 cm) long, and 0.8 to 4 in (2 to 9 cm) wide. The small flowers are borne in axillary clusters. The fruits are reddish brown to black, juicy, globose, and 0.11 to 0.22 in (3 to 6 mm) in diameter. Three trees were found in 1994, one each at Mikilua, Kauhiuhi, and in Hālona (within NAVMAG PH Lualualei Branch). All three trees were found alive in 2004; however, the Mikilua tree is dead and the Kauhiuhi tree was mostly dead. The Hālona tree was surveyed in 2010 by Navy staff and is healthy. All three trees showed signs of black twig borer infestation.
Not available	 Photo 4-16: *Hedyotis parvula* (A. Gray) Fosb.	NCN	*Hedyotis parvula* (A. Gray) Fosb. (Photo 4-16) is a member of the coffee Family. Endemic to Wai'anae Mountains of O'ahu. Found on steep, mesic cliffs. *H. parvula* is a small, erect to sprawling, many-branched shrub. The laceolate to ovate-cordate leaves are 0.4 to 1.6 in (1 to 4 cm) long and 0.3 to 0.9 in (0.7 to 2.3 cm) wide. The leaves have slightly revolute margins and are usually closely spaced and overlapping. The flowers are perfect or pistillate (containing only female parts), in narrow corymbose inflorescences that may sometimes be grouped together to give the appearance of one large inflorescence. The flowers are white with purplish-pink tinge toward the tips. Four plants were observed at the Wai'anae summit ridge into Hālona (within NAVMAG PH Lualualei Branch) in 1994; only one plant was found there in 2004. However, 11 plants were found below the ridge top in 2003.

Table 4-3: Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch (Continued)

Hawaiian Name	Photograph/Latin Binomial	Common Name	Comments
ʻānaunau, naunau, kūnānā	 *Photo 4-17: Lepidium arbuscula Hillebr*	NCN	ʻĀnaunau (Photo 4-17) is a member of the mustard Family. Endemic to Waiʻanae Mountains. Occurs in dry to mesic habitats, in open shrubby or grassy areas, sparsely vegetated cliffs, and so*metimes in scrubby forest. L. arbuscula* is a shrub 2 to 4 ft (0.6 to 1.2 m) tall. The leaves are crowded at the ends of the branches, and are 1 to 2 in (2.6 to 6.0 cm) long and 0.3 to 0.7 in (0.8 to 1.8 cm) wide. The small white flowers are borne on one to three erect, simple racemes 3 to 6 in (7 to 15 cm) long. More than 700 plants were seen in Puʻu Kaua and in Hālona (within NAVMAG PH Lualualei Branch) in 1994. No obvious change in abundance was noted for these same areas in 2004.
nehe	 Photo 4-18: *Lipochaeta lobata* var. *leptohpylla* (Gaud.)	NCN	*Lipochaeta lobata* (Gaud.) (Photo 4-18) is endemic to the leeward side of the Waiʻanae Mountains. Occurs in dry to mesic habitats on open, grassy or shrubby ridges and cliffs. *L. lobata* var. *leptopylla* is a somewhat woody, perennial herb, with stems arching or decumbent. The leaves are closely spaced, lanceolate to linear lanceolate, and up to 4 in (9.7 cm) long. Flowers are borne in heads with 20 to 65 disk florets and 8 to 15 yellow ray florets. A total of 140 plants were observed at Mikilua and Kauhiuhi (within NAVMAG PH Lualualei Branch) in 1994. A bigger area was surveyed in 2004 with an estimate of 300 plants at Mikilua.

Table 4-3: Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch (Continued)

Hawaiian Name	Photograph/Latin Binomial	Common Name	Comments
ʻōhā, hāhā, ʻōhāwai	 Photo 4-19*: Lobelia niihauensis* St. John	NCN	(Photo 4-19) is a member of the bellflower family. Endemic to Waiʻanae Mountains. Found growing on cliffs in dry and mesic habitats. *L. niihauensis* is a branched shrub with branches 8 to 16 in (20 to 40 cm) long. Each branch bears an apical rosette of leaves 3 to 6 in (7 to 15 cm) long and 0.3 to 0.7 in (0.7 to 1.8 cm) wide. The unbranched inflorescences, 5 to 6 in (12 to 15 cm) long, bear magenta flowers. More than 90 plants observed in many locations (within NAVMAG PH Lualualei Branch) in 1994. No obvious change in plant abundance observed in 2004. Several new locations were found in Pūhāwai and Mikilua subdistricts.
ʻihiʻihi, ihi laʻau	 Photo 4-20: *Marsilea villosa* Kaulf.	NCN	ʻIhiʻihi (Photo 4-20) is a member of the water-clover family. Endemic. Found in dry areas, usually in depressions that flood during heavy winter rains and dry out completely during the summer. *M. villosa* is an aquatic fern with creeping rhizomes. The stipes are in clusters of 2-65 per node. The fronds bear four fan-shaped pinnae 0.8 to 1.0 in (2 to 2.5 cm) long and 0.89 to 0.90 in (22-23 mm) wide that arise closely from a short rachis, giving an appearance of a "four-leafed clover." The sori are contained in hard, nut-like sporocarps (spore-bearing structures) borne at the stipe bases. The sporocarps bear two types of spores: microspores and larger megaspores. *M. villosa* is dispersed into seven populations – six at NRTF Lualualei and one at NAVMAG PH Lualualei (Figure 4-6). A small colony of the ferns is located in a depression of a former cane-haul road located in a former cattle-grazing lot in the northwestern corner of NAVMAG PH Lualualei Branch. Three populations occur in the NRTF Lualualei antenna fields which are regularly mowed. Another population located in a sparse kiawe forest area is not maintained but was previously used for cattle grazing. All populations of *M. villosa* are monitored year round.

Table 4-3: Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch (Continued)

Hawaiian Name	Photograph/Latin Binomial	Common Name	Comments
ma'aloa, ma'oloa, 'oloa	 Photo 4-21: *Neraudia angulata R. Cowan var. dentate Deg. & R*	NCN	Ma'aloa (Photo 4-21) is a member of the nettle family. Endemic to Wai'anae Mountains. *N. angulata* is an erect shrub 5 to 10 ft (1.5 to 3.0 m) tall. Its leaves are elliptic, elliptic-ovate, or ovate, 0.4 to 6 in (1 to 15 cm) long and 1 to 2 in (3.0 to 5.5 cm) wide. The leaf undersides are hairy, the hairs project outward, and the leaf margins are sometimes coarsely toothed above the middle. The plants are unisexual, bearing either female or male flowers. The flowers are small, and tightly clustered in the leaf axils. The fruit is also small, and conspicuously angled and ridged. Approximately 24 plants were observed at several spots in Mikilua, on Pu'u Kaua, and in Hālona (within NAVMAG PH Lualualei Branch) in 1994; however, only 14 plants were observed at these same locations in 2004.
Not available	*Neraudia angulata var. angulata*	NCN	*Neraudia angulata var. angulata* is an erect shrub with elliptic leaves; male and female flowers on separate plants. It can be found on slopes, ledges, and gulches in moist forest including locations within NAVMAG PH Lualualei Branch. The plant is endemic and can be found in mesic forests. Its mature height is 6 to 11 ft (1.8 to 3.4 m) with a 6 ft (1.8 m) spread. It has simple leathery green leaves with three nerved veins. The leaf undersides are hairy with hairs laying close to the surface creating a silvery sheen. Margins are untoothed.

Table 4-3: Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch (Continued)

Hawaiian Name	Photograph/Latin Binomial	Common Name	Comments
kulu'i	 Photo 4-22: *Nototrichium humile Hillebr*	NCN	Kulu'i (Photo 4-22) is a member of the amaranth family. Endemic, occurs mainly in the Wai'anae Mountains in dry and mesic forests from 200 to 2,300 ft (60 to 700 m). *N. humile* is a shrub with erect to decumbent stems that are 3 to 16 ft (1 to 5 m) long. Its leaves are ovate to oblong, 1 to 4 in (3 to 9 cm) long, and 0.8 to 2 in (2 to 5 cm) wide. Its small, inconspicuous flowers and fruits are borne on slender spikes 1.2 to 6 in (3 to 14 cm) long. About 20 plants were observed on Puukaua and in Mikilua (within NAVMAG PH Lualualei Branch) in 1994. There was no obvious change in plant abundance in 2004.
laukahi kuahiwi	 *Photo 4:23: Plantago princeps var. princeps*	NCN	*Plantago princeps var. princeps* (Photo 4-23) is an endemic herbaceous plant found in wet forests. Its mature height is less than 1 ft (0.3 m) with a 2 ft (0.6 m) spread. It has simple green leather leaves with small abundance flowers on inflorescene. Leaves narrowly oblong to elliptic (6-30 cm) long and 1.5-5 cm wide. Several scapes 10-50 cm long, flowers arranged on spikes 11-28 cm long densely crowded. Not identified in the HNHP survey.

Table 4-3: Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch (Continued)

Hawaiian Name	Photograph/Latin Binomial	Common Name	Comments
Not available	 Photo 4-24: *Schiedea hookeri A. Gray*	NCN	*Schiedea hookeri A. Gray* (Photo 4-24) is a member of the pink family. Endemic, occurs mainly in the central and northern Wai'anae Mountains in dry and mesic forests from 1,197 to 2,953 ft (365 to 900 m). *S. hookeri* is a sprawling or clumped perennial herb, with stems 12 to 16 in (30 to 50 cm) long. The leaves are opposite, narrowly lanceolate to narrowly elliptic, 1 to 3 in (3 to 8 cm) long, and 0.02 to 0.06 in (0.4 to 1.5 cm) wide. The conspicuous flowers are borne in open paniculata cymes 2 to to 9 in (5 to 22 cm) long. The fruit is a capsule about 0.01 to 0.012 in (2.5 to 3.0 mm) long. About 20 plants were observed in Mikilua and Pu'u Kaua (within NAVMAG PH Lualualei Branch) in 1994. No obvious change in abundance was noted in 2004.
Not available	 Photo 4-25: *Spermolepis hawaiiensis Wolff*	NCN	*Spermolepis hawaiiensis Wolff* (Photo 4-25) is a member of the parsley family. Endemic. Occurs in dry shrublands and forests from 1,000 to 6,398 ft (305 to 1,950 m). *S. hawaiiensis* is a slender, erect annual herb 2 to 8 in (5 to 20 cm) tall, and is essentially hairless. Its leaves are finely dissected, and measure from 0.4 to 1.6 in (1 to 4 cm) long. The small white flowers are borne in compound umbels. The fruits are void, 0.12 to 0.16 in (3 to 4 mm) long, 0.08 to 0.16 in (2 to 4 mm) wide, and are covered with irregularly arranged tubercles, some of which bear slender hooked bristles. In 2004, two individuals were seen within the boundaries of NAVMAG PH Lualualei in 2004 and hundreds more were observed a few yards beyond the boundary at Kauaopuu.

Table 4-3: Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch (Continued)

Hawaiian Name	Photograph/Latin Binomial	Common Name	Comments
Not available	 Photo 4-26: *Tetramolopium filiforme Sherff*	NCN	*Tetramolopium filiforme Sherff* (Photo 4-26) is a member of the sunflower family. Narrowly endemic to leeward northern Waiʻanae Mountains. Occurs in dry to mesic habitats usually on exposed, sparsely vegetated ridge tops and cliff faces from 1,000 to 3,051 ft (305 to 930 m). *T. filiforme* is a shrub 2 to 6 in (5 to 15 cm) tall. Its leaves are 0.4 to 0.8 in (10 to 20 mm) long and 0.016 to 0.047 in (0.4 to 1.2 mm) wide. The flower heads are borne on peduncles 0.8 to 1.9 in (2 to 4.7 cm) long, and are solitary or two to four in an inflorescence. There are 35 to 52 ray florets and 18 to 30 disk florets in the flower head, and the rays are white or pale lavender. Two small plants were observed at Puʻu kū Makaliʻi (within NAVMAG PH Lualualei Branch) in 1986. Seven mature plants and one immature plant were observed at the same site in 2004. Navy staff observed a large population of these plants on a cliff face along Kolekole Pass Road.
pāmakani	 Photo 4-27: *Viola chamissoniana Ging. sp. Chamissoniana*	NCN	Pāmakani (Photo 4-27) is a member of the violet family. Endemic to the Waiʻanae Mountains. It can be found in mesic habitats, usually on exposed steep slopes and cliffs, and ranges from 2,297 to 3,034 ft (700 to 925 m). *V. chamissoniana* subspecies *chamissoniana* is a small, branched shrub with leaves about 0.8 to 1.6 in (2 to 4 cm) long. One to two white flowers are borne per peduncle. The fruit is a capsule 4 to 8 in (10 to 20 mm) long. Three plants were observed on the top of a ridge extending from the Waiʻanae Ridge Summit into Hālona (within NAVMAG PH Lualualei Branch) in 1994. No plants were found on the ridge top in 2003; however, 32 mature and 3 immature plants were observed below the ridge top.

Table 4-3: Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch (Continued)

Hawaiian Name	Photograph/Latin Binomial	Common Name	Comments
Status: Federal Candidate Species			
pilokea	 Photo 4-28: *Platydesma cornuta*	NCN	Pilokea (Photo 4-28) is a member of the rue Family. Endemic to Wai'anae Mountains from 2,001 to 2,920 ft (610 to 890 m). *P. cornuta* var. *decurrens* is an erect, sparingly branched shrub, usually 3 to 7 ft (1 to 2 m) tall, with leaves clustered at the branch tips. The leaves are 5 to 16 in (12 to 40 cm) long and 2 to 5 in (5 to 13 cm) wide. Its flowers are borne in short axillary inflorescences on the bare stems below the leaves. The flowers are white with petals 0.4 to 0.6 in (9 to 16 mm) long. The plant was observed within NAVMAG PH Lualualei Branch. One individual was seen in 1994. This individual was not found during the 2004 surveys by the HNHP.
halapepe	 Photo 4-29: *Pleomele forbesii Degener*	NCN	Halapepe (Photo 4-29) is a member of the agave family. Endemic primarily to the Wai'anae Mountains. Occurs in dry to mesic forests from 803 to 2,903 ft (245 to 885 m). *P. forbesii* is a tree 10 to 23 ft (3 to 7 m) tall and usually sparingly branched. The leaves are 9 to 15 in (24 to 37 cm) long and 0.5 to 1.2 cm wide. The panicles are about 6 to 14 in (15 to 35 cm) long, bearing greenish-yellow flowers 2.1 to 2.3 in (52 to 60 mm) long. The berries are red and about 0.40 to 0.43 in (10 to 11 mm) long. One individual is along the trail to the Mikilua management area within NAVMAG PH Lualualei Branch.

Table 4-3: Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch (Continued)

Hawaiian Name	Photograph/Latin Binomial	Common Name	Comments
Status: Federal Species of Concern			
'ahakea .	 Photo 4-30: *Bobea sandwicensis (A. Gray) Hillebr*	NCN	'Ahakea (Photo 4-30) is a member of the coffee family. Grows in dry to mesic forests between 295 and 3,002 ft (90 to 915 m). *B. sandwicensis* is a tree up to 33 ft (10 m) tall with leaves 2.6 to 4.5 (6.5 to 11.5 cm) long. Its trumpet-shaped flowers are either perfect (having both male and female parts) or functionally unisexual. The male and perfect flowers are borne in cymes of three to seven flowers. The female flowers are solitary or, rarely, with two or three per cyme. The leaf-like calyx lobes are usually unequal. Its fruits are somewhat round and 0.2 to 0.4 in (6 to 10 mm) wide. The plant was observed within NAVMAG PH Lualualei Branch from Kolekole pass to Hālona.
kāmakahala	 Photo 4-31*: Labordia kaalae C. Forbes*	NCN	Kāmakahala (Photo 4-31) is a member of the logania family. Endemic to Wai'anae Mountains. Recorded in mesic forests at elevations from 1,903 to 3,806 ft (580 to 1,160 m). *L. kaalae* is a shrub or small tree 7 to 20 ft (2 to 6 m) tall. Its leaves 2 to 7 in (6 to 17 cm) long and 1 to 3 in (2.5 to 7.0 cm) wide. The small green to yellowish-green flowers are borne in open inflorescences, with 9 to 25 flowers per inflorescence. The fruits are two-valved, broadly ovoid capsules 0.5 to 0.8 in (12 to 20 mm) long. Plants were observed within NAVMAG PH Lualualei Branch in the Pu'u Hāpapa area in 2004.

Table 4-3: Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch (Continued)

Hawaiian Name	Photograph/Latin Binomial	Common Name	Comments
pānaunau .	 Photo 4-32*: Lobelia yuccoides Hillebr*	NCN	Pānaunau (Photo 4-32) is a member of the bellflower family. Endemic to Wai'anae Mountains. Found in mesic forests and shrublands from 2,297 to 4,035 ft (700 to 1,230 m). *L. yuccoides* has erect stems 5 to 7 ft (1.5 to 2.0 m) long, with a dense apical rosette of leaves. The leaves are linear, 9 to 14 in (24 to 35 cm) long, and 0.2 to 0.6 in (0.5 to 1.5 cm) wide. The leaf and 24 to 40 in (60 to 100 cm) long. The corolla of the flower is blue to lilac, 1.4 to 1.6 in (36 to 40 mm) long, and 0.12 to 0.20 (3 to 5 mm) wide. Eight plants were seen in the Halona near the summit ridge between the Pohakea pass and Palikea within NAVMAG PH Lualualei Branch.
nehe	 Photo 4-33: *Melanthera tenuis (Degener and Sherff) W.L. Wagner* and H. Rob.	NCN	Nehe (Photo 4-33) is a member of the sunflower family. Endemic to central Wai'anae Mountains in dry to mesic forests, often in shrublands and grasslands on open exposed ridges, from 1,017 to 3,117 ft (310 to 950 m). *M. tenuis* is a somewhat woody perennial herb, with stems decumbent, 1 to 5 ft (0.3 to 1.5 m) long. Its leaves are ovate to deltate, 0.9 to 1.7 in (2.2 to 4.4 cm) long and 0.4 to 0.8 in (1.0 to 2.1 cm) wide, sometimes with two or four basal lobes. Its flowers are borne in heads with 30 to 60 disk florets and 8 to 12 yellow ray florets. The plant was observed within NAVMAG PH Lualualei Branch.

Table 4-3: Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch (Continued)

Hawaiian Name	Photograph/Latin Binomial	Common Name	Comments
ma'aloa, ma'oloa, 'oloa .	 Photo 4-34: *Neraudia melastomifolia Gaud*	NCN	Ma'aloa (Photo 4-34) is a member of the nettle family. Endemic. Occurs in mesic and sometimes wet forests at elevations ranging from 902 to 4,003 ft (275 to 1,220 m). *N. melastomifolia* is a shrub or small tree up to 13 ft (4 m) tall. Its leaves are elliptic, elliptic-ovate, ovate, or lanceolate; and are 2 to 9 in (5 to 24 cm) long and 0.6 to 3 in (1.5 to 7.0 cm) wide. The plants are unisexual, bearing either female or male flowers. The flowers and fruits are small, and tightly clustered in the leaf axils. Several plants were seen in the Hālona area not far below the summit ridge within NAVMAG PH Lualualei Branch.
Not available	 Photo 4-35: *Schiedea pentandra*	NCN	*Schiedea pentandra* (Photo 4-35) is a member of the pink family. Endemic to Wai'anae Mountains. Occurs in mesic and wet forests from 1,755 to 3,198 ft (535 to 975 m). *S. pentandra* is a reclining or weakly climbing vine, with stems 3 to 20 ft (1 to 6 m) long. The leaves are opposite, narrowly lanceolate, 1.8 to 6.1 in (4.5 to 15.5 cm) long and 0.3 to 2.2 in (0.8 to 5.5 cm) wide, and sometimes purple tinged. The inflorescens are open paniculata cymes 12 to 60 (30 to 150 cm) long, with small, inconspicuous flowers. The fruit is a capsule 0.10 to 0.14 in (2.5 to 3.5 mm) long. A group of plants was seen on the summit ridge of PuuHāpapa within NAVMAG PH Lualualei Branch.

Source: HNHP 2004a

NCN = no common name

Finds of non-target, rare plants and animals included a new record for Lualualei of the rare vine *Sicyos lanceoloideus*. It was found at two locations, one of which is at the boundary of NAVMAG PH Lualualei. Also, within the boundary of the installation on Pu'u Hāpapa, the only known population of the native land snail *Amastra intermedia* was confirmed to be still surviving, and fresh shells of the federally-listed endangered tree snail *Achatinella mustelina* were found, indicating that the population of the species likely survives (HNHP 2003).

2. NRTF Lualualei

Three federally-listed endangered plants species occur at NRTF Lualualei: (1) *Marsilea villosa*; (2) ko'oloa'ula (*Abutilon menziesii)*; and (3) pu'uka'a (*Cyperus trachysanthos)*. Critical habitat was designated for *Marsilea villosa* within NRTF Lualualei (Figure 4-2). These species are described in Table 4-3.

4.3.1.3 Special Management Areas

There are four SMAs which are mainly located on the steep slopes and close to ridges of the valley within NAVMAG PH Lualualei Branch (Figure 4-1): (a) Pu'u Hāpapa Management Area; (b) Hālona Valley Management Area; (c) Pu'u Kaua Management Area; and (d) Pu'u Ka'īlio Management Area. Threatened and endangered plant and animal species are found in these SMAs which were selected based on their numbers of native plants, animals, and endangered taxa, and potential for gain. The following SMA descriptions were derived from the 2001 INRMP for NAVMAG PH (DON 2001b).

1. Pu'u Hāpapa SMA

The 30-ac (12.1-ha) Pu'u Hāpapa SMA (Figure 4-1) contains one of two Navy installed fenced exclosures designed to protect rare plant communities by excluding feral ungulates. It consists of three types of habitat with three different types of vegetation. Sections in the lower unit are about 90 percent native vegetation; large areas in the upper unit are 50 to 60 percent native; and cliff faces have a high percentage of native species. The exclosure (Photo 4-36) was constructed in the lower unit of the SMA. The area is habitat for 10 federally-listed endangered animal or plant species and federal species of concern: (1) *Achatinella mustelina*; (2) *Chasiempis sandwichensis ibidis*; (3) *Abutilon sandwicense*; (4) *Alectryon macrococcus* var. *macrococcus*;(5) *Bonamia menziesii*; (6) *Flueggea neowawraea*; (7) *Lipochaeta lobata* var*. leptophylla*; (8) *Lobelia niihauensis*; (9) *Nototrichium humile*; and (10) *Schiedea hookeri*.

Photo 4-36: exclosure fencing at NAVMAG PH Lualualei Branch

The 2006 Lualualei Botanical Projects Report (NAVFAC PAC 2006e) reported that the Pu'u Hāpapa exclosure contains a rare lama (*Diospyros sandwicensis*) forest that provides habitat for three endangered plant species (*Flueggea neowawraea, Notorichium humile, A. sandwicehse*) and one species of concern, *Pleomele forbesii*. Other endemic plant species are also present. Two federally-listed endangered plant species, *Bonameia menziesii* and *Lipochaeta lobata,* had

previously been identified at the exclosure but were not observed in 2006 (NAVFAC PAC 2006e).

2. Hālona Valley SMA

The Hālona Valley SMA (Figure 4-1) is comprised of approximately 280 ac (113.3 ha) and also contains and exclosure. Most of the SMA is covered by Christmas berry forest, but patches as large as an acre (0.4 ha) are found that can be vegetated with 60 to 70 percent native species. The exclosure was constructed to protect a small forest of native trees, including a population of federally-listed endangered *Abutilon sandwicense* and rare lama (*Diospyros sandwicensis*) forest, on one of the ridges in the SMA. The SMA is also habitat for the following five federally-listed endangered plant species: (1) *Flueggea neowawraea*; (2) *Hedyotis parvula*; (3) *Lobelia niihauensis*; (4) *Neraudia angulata var. dentate*; and (5) *Viola chamissoniana sp. Chamissoniana*.

The 2006 Lualualei Botanical Projects Report (NAVFAC PAC 2006e) reported on the Hālona (Hālona District) exclosure protected rare lama and lonomea (*Sapindus oahuensis*) plant communities from destruction from feral ungulates. These plant communities contain high concentrations of endangered species including *Abutilon sandwicense, Bonamia menziesii, Flueggea neowawrae, Nototrichium humile,* and *Lipochaeta lobata*.

3. Puʻu Kaua SMA

The Puʻu Kaua SMA (Figure 4-1) is comprised of 125 ac (50.6 ha) with the majority located on the steep vertical cliff faces of Puʻu Kaua. The lowlands below the cliffs are largely alien forests with the dominant trees being kukui (*Aleurites moluccana*) and koa haole (*Leucaena leucocephala*). Small pockets of native forest can be found on the northern side of the SMA and a small native forest occupies the northern slope of Puʻu Kaua. The area is habitat for the following seven federally-listed endangered plant species: (1) *Flueggea neowawraea*; (2) *Lepidium arbuscula; (3) Lipochaeta lobata* var. *leptophylla; (4) Lebelia niihauensis; (5) Neraudia angulata* var. *dentate; (6) Nototrichium humile;* and (7) *Schiedea hookeri*.

4. Puʻu Kaʻīlio SMA

The Puʻu Kaʻīlio SMA (Figure 4-1) contains approximately 247 ac (100 ha). Certain parts of the SMA are almost exclusively alien vegetation such as koa haole and prickly pear (*Opuntia ficus-indica*). But there are many areas that have sparse populations of native dry lowland plants and other sections with native shrubs on cliff faces. The SMA includes habitat for the following federally-listed endangered plant and animal species: (1) *Achatinella* ssp. (an endangered tree snail); (2) *Chamaesyce kuwaleana* (endangered plant); and (3) *Lobelia niihauensis* (endangered plant) (DON 2001b).

4.3.2 Wetlands

4.3.2.1 NAVMAG PH Lualualei

The USFWS classified three areas of Lualualei Valley as wetlands: (1) Māʻiliʻili Stream; (2) the northern unnamed tributary to Māʻiliʻili Stream; and (3) channeled Ulehawa Stream in the southern part of the Station. Māʻiliʻili Stream and its unnamed northern tributary are classified as "Riverine system, intermittent subsystem, streambed class, seasonal, non tidal." The channeled Ulehawa Stream is classified as a "Riverine system intermittent subsystem, streambed class, seasonal; non-tidal, excavated" (DON 2001b).

4.3.2.2 NRTF Lualualei

Photo 4-37: Niuli'i Ponds during a wet period

The wetlands at NRTF Lualualei are limited to a man-made wetland (Niuli'i Ponds) (Photos 4-37 and 4-38) located within the Navy's Niuli'i Wildlife Refuge located on the southeastern corner of the installation, a portion of the intermittent Mā'ili'ili Stream located along the northern boundary of the installation, and the downstream reservoir.

The Niuli'i Ponds Wildlife Refuge was established in 1972 on an approximately 88 ac (35 ha) site in the southeastern corner of NRTF Lualualei. The Niuli'i Ponds consist of 9.6 ac (3.9 ha) of stabilization and oxidation ponds that are dependent on the flow of stormwater runoff and wastewater effluent from the adjacent NAVMAG PH Lualualei Branch. The refuge and ponds exist because the stabilization and oxidation ponds developed into a wetland and attracted waterbirds including the four federally-listed endangered waterbirds (Hawaiian black-necked stilt, Hawaiian common moorhen, Hawaiian duck, and Hawaiian coot) (Section 4.3.1.1).

Photo 4-38: Niuli'i Ponds during a dry period

Because personnel are no longer housed at NAVMAG PH Lualualei Branch, the inflow of water, particularly wastewater effluent, has decreased significantly. In the past five years or so, the Navy has utilized the minimal flows of wastewater effluent from NAVMAG PH Lualualei and groundwater pumped from a solar-powered pump to provide water for the pond. On average, the standing water at the ponds has been reduced to an area of approximately 1 ac (0.4-ha).

Niuli'i is a "supporting wetland," which is defined by the USFWS as a wetland that provides habitat important for smaller waterbird populations or provides habitat needed seasonally by segments of the waterbird populations during a part of their life cycle. As such, the USFWS recommended the following: (1) development and implementation of a management plan; (2) secure water resources and manage water levels; (3) manage vegetation; (4) reduce and control predators; (5) minimize human disturbance to the waterbirds and their habitat; (6) monitor and control avian disease; (7) monitor populations of endangered waterbirds; and (8) remove threat of mallard hybridization (NAVFAC PAC 2006c).

4.3.3 Ecosystems

The classification of the Lualualei INRMP Study Area's native terrestrial ecosystem is "lowland dry shrubland and grassland and mesic forest, woodland, and shrubland." This ecosystem is found in undeveloped portions of the study area. Forests and woodlands are dominated by trees; and a forest canopy is dense (60 to 100 percent cover), while a woodland canopy is more open (10 to 60 percent). Shrublands are distinguished by multi-branched shrubs over 3.3 ft (1 m) in height (Juvik and Juvik 1998).

4.3.4 Fish and Wildlife

The discussion of terrestrial animals at NAVMAG PH Lualualei Branch and NRTF Lualualei is limited to: (1) birds; (2) mammals; (3) amphibian and reptile species; (4) snail species; and (5) arthropod species.

4.3.4.1 Bird Species

1. NAVMAG PH Lualualei Branch

A total of 29 bird species were observed during the 2004 survey by HNHP (2004a) (Appendix C10). One federally-listed endangered bird species (O'ahu 'elepaio, Section 4.3.1.1) and one SOH-listed endangered (on O'ahu) bird species (Hawaiian short-eared owl, Section 3.3.1.1) occur at NAVMAG PH Lualualei Branch. In addition, there are two MBTA-protected bird species that are present: (1) white-tailed tropicbird (*Phaethon lepturus*); and (2) Pacific golden plover (Section 3.3.4.1). Alien or exotic, introduced birds are the most visible and conspicuous wildlife at the installation. The most frequently observed alien bird species include: house finch (*Carpodacus mexicanus*); Japanese white-eye; zebra dove; spotted dove; northern cardinal (*Cardinalis cardinalis*); and red-vented bulbul (*Pycnonotus cafer*). Game birds have been observed at the installation including: Erckel's francolin (*Francolinus erckelli*); common peafowl (*Pavo cristatus*); and rock dove (*Columba livia*) (HNHP 2004a).

White-tailed Tropicbird

Photo 4-39: white-tailed tropicbird

White-tailed tropicbirds (Photo 4-39) have been observed soaring at high levels above the cliffs at Lualualei Valley. Cliffs are important habitat for this bird where they lay eggs in rock crevices or burrows in the cliff face. It is likely that the white-tailed tropicbirds are nesting throughout the cliffs of Lualualei Valley. Introduced rock doves are also observed in these areas and compete with the white-tailed tropicbirds for nesting space (HNHP 2004a). Protected under the MBTA, white-tailed tropicbirds are medium-sized, aerial seabirds and are the smallest of the tropicbirds. While out to sea, white-tailed tropicbirds forage on small surface-dwelling pelagic fish and squid. In Hawai'i, they nest from March through October and lay one egg. It is estimated that incubation lasts between 70 and 80 days. A 1990 estimate of the population around the main Hawaiian Islands was 300 to 500 pairs (NAVFAC 2006a).

Native Forest Birds

Few native forest birds relative to the number of non-native forest birds were observed as part of the 2004 bird surveys at NAVMAG PH Lualualei (HNHP 2004a). It was not possible to determine if there was a change in species composition between an initial survey completed in 1994 and the 2004 survey because survey methods differed and the 1994 survey did not indicate numbers of non-native species detected. The reason for low numbers of native species in NAVMAG PH Lualualei are likely the same as those responsible for the decline and extinction of many Hawaiian birds: habitat loss, competition from non-native birds, mosquito-borne avian disease, and predation from introduced mammalian predators (HNHP 2004a).

In addition to competing for resources, exotic birds serve as a source for mosquito-borne avian disease, and they tend not to be susceptible to these diseases. During the course of the survey, biologists encountered high numbers of mosquitoes, a vector for avian malaria

(*Plasmodium relictum*) and pox (*Poxvirus avium*). The introduction of mammalian predators is postulated as one of the main causes of the extinction and decline of Hawaiian avifauna species. Hawaiian birds are naive to mammalian predators whereas most or all introduced bird species are not.

2. NRTF Lualualei

Bird surveys have been conducted at NRTF Lualualei. Appendix D5 provides a list of the birds recorded at the installation in 1984 (DON 2001c) and 2004 (HNHP 2004b). There are four endemic, federally-listed endangered waterbird species within the NRTF Lualualei: (1) Hawaiian black-necked stilt (2) Hawaiian moorhen; (3) Hawaiian coot; and (4) Hawaiian duck. These species are described in Section 3.3.1.1. There is one SOH-listed endangered (on O'ahu) species at the installation: the Hawaiian short-eared owl (Section 3.3.1.1).

Two indigenous (i.e., native to Hawai'i and other locations) MBTA-protected bird species are located at NRTF Lualualei: (1) black-crowned night heron which is generally associated with wetland areas (Section 3.3.4.1); and (2) Pacific golden plover, a migratory wading bird (Section 3.3.4.1). Black-crowned night herons are observed on an irregular basis at the refuge. However, since water levels were increased in 2005, herons were observed more frequently at the refuge (NAVFAC PAC 2006c). Cattle egrets are an MBTA-protected bird species that were introduced to Hawai'i. They are common on O'ahu and are commonly observed at NRTF Lualualei. They forage in the antenna fields and like to roost in kiawe trees near the refuge. They predate on federally-listed, endangered Hawaiian black-necked stilt chicks (NAVFAC PAC 2006c)

The most common bird species observed at NRTF Lualualei is the zebra dove which is associated with all principal habitats on the station (buffelgrass meadow, wooded areas, and wetlands). Other common birds include the red-crested cardinal (*Paroaria coronata*), Japanese white-eye, common mynah (*Acridotheres tristis*), spotted dove, and cattle egret (HNHP 2004b).

4.3.4.2 Mammal Species

1. NAVMAG PH Lualualei Branch

The only mammals observed at NAVMAG PH Lualualei Branch are alien species including: (1) mongooses (*Herpestes auropunctatus*); (2) feral cats; (3) feral dogs; (4) feral pigs; and (5) several species of introduced rodents (DON 2001b).

There were several goat populations within the installation, primarily on open ridges; however, they were significantly reduced in 2001 by the USDA-WS. In the 1990s, three specific subpopulations were identified: (1) 15 goats on Lualualei Ridge between Palikea and Haleakalā; (2) 25 to 30 goats on the slopes of Pu'u Kaua above Hālona Valley; and (3) six to 10 goats on the ridge extending northwest from Pu'u Hāpapa. These small populations were believed to be isolated from larger goat populations in the northern Wai'anae Mountain Range. They were eradicated in 2001 and are not expected to reestablish in the southern part of the range.

Because of the mobility of goats, an informal partnership among the Navy, U.S. Army, Nature Conservancy, and DLNR has been in effect since 1995 to address the issue of goats crossing jurisdictional boundaries. This partnership is necessary for access to adjacent lands in the attempt to eradicate goats in and near the installation. This informal partnership ensures that the landowners have a common goal which is important to ensure that the goats do not

reestablish at the installation or the southern Wai'anae Mountain Range at some later time after they have been eradicated. In the past, the Navy has conducted monthly ground hunts with supplemental air operations to control and eradicate feral goats on the installation (DON 2001b).

2. NRTF Lualualei

Mammals trapped at Niuli'i Ponds Wildlife Refuge by USDA-WS include cats, dogs, mice, rats, and mongoose (NAVFAC PAC 2006c). Tracks and other evidence of feral pigs within NRTF Lualualei have also been observed (USDA in DON 2001c).

4.3.4.3 Amphibian and Reptile Species

1. NAVMAG PH Lualualei Branch

The house gecko (*Hemidactylus frenatus*) and mourning gecko (*Lepidodactylus lugubrus*) were found during surveys of Lualualei Valley. Ground skinks and *Anolis* sp. were not documented, but may occur in the more urban areas around human structures and habitations. *L. lugubrus* are not native, but are thought to have arrived with the first Polynesian canoes (NAVFAC PAC 2006d).

2. NRTF Lualualei

An amphibian and reptile species survey was not conducted for the NRTF Lualualei; the Navy focused amphibian and reptile species (herpetological) surveys on forested areas where these species are of more interest from an ecological/invasive species perspective.

4.3.4.4 Snail Species

1. NAVMAG PH Lualualei Branch

Navy-owned lands in the upper elevations of the Wai'anae Mountains surrounding NAVMAG PH Lualualei contain native snails including the federally-listed endangered snail *Achatinella mustellina* (Section 4.3.1.1) and the extremely rare snail *Amastra* cylindrical (Section 4.3.1.1). In addition to *A. musteillina* and *A. Cylindrical*, five other endemic snails have been observed within NAVMAG PH Lualualei Branch: (1) *Succinea caduca*; (2) *Tornatellides* sp.; (3) *Leptachatina*; (4) *Lymneidae* sp.; and (5) *Philonesia*.

4.3.4.5 Arthropod Species

NAVMAG PH contains more arthropod species endemic to Hawai'i than any other property owned by the Navy. A year long arthropod study conducted at NAVMAG PH Lualualei in 1995 by entomologists from the Bishop Museum found that 21 percent of the 637 total insects and related arthropods collected were native to Hawai'i. The results from the 1995 survey also indicated that Hālona Valley supports the greatest number of native insects when compared to other areas surveyed within NAVMAG PH Lualualei. Of specific interest at Hālona Valley is *Rynchogonus welchii*, a rare weevil that has never been collected anywhere else in the world and has not been found alive since 1976 (NAVFAC PAC 2007a).

Pūhāwai Valley, also located in NAVMAG PH Lualualei, is significant due to the fact that it currently contains the area's only permanent stream, Pūhāwai Stream (Figure 4-1). Although no native Hawaiian damselflies (genus *Megalagrion*) were detected at Pūhāwai Stream, the upper reaches of the stream were found to be free of poeciliid fish (family Poeciliidae, i.e., mosquito fish), one of the major predators of *Megalagrion* (NAVFAC PAC 2006f). The upper portions of Pūhāwai Stream are therefore considered ideal habitat for *Megalagrion*.

In 2006, NAVFAC PAC biologists conducted arthropod surveys at Hālona Valley and surveyed for endemic Hawaiian damselflies at Pūhāwai Falls. No adult damselflies, alien or endemic, were observed along Pūhāwai Stream from the Kolekole Road bridge up to Pūhāwai Falls. A damselfly was sighted near the stream above the falls; however a determination on the species could not be made.

Results of the survey of Hālona Valley did not reveal exoskeletal fragments or other evidence of *R. welchii*. A total of 102 species from 14 orders were collected from Hālona Valley with endemic and indigenous arthropod species estimated to be about eight percent. Further confirmation is needed on identification; however, the following arthropods represent possible new records for Hālona Valley: (1) *Talitroides topitum*, alien terrestrial amphipod; (2) *Anthrax distigma,* alien bee fly; (3) *Entomobryidae* sp, elongate bodied springtails (possibly endemic); (4) *Solenopsis papuana*, alien ant species; (5) *Hyposmocoma* sp., small endemic moth; and (6) *Thiraptera* sp., alien thrip.

The Tahitian prawn, *Macrobrachium lar*, was seen in the stream near the Kolekole Road bridge, but was not detected further than 30 ft (10 m) upstream from this location. Approximately 300 ft (100 m) upstream from the bridge, the stream flowed over exposed rock. This apparently acts as a fish barrier since no fish were observed upstream from this location. The wrinkled frog, *Rana rugosa*, was common throughout the stream up to Pūhāwai Falls. The frog was not observed in the stream above the falls.

4.3.5 Vegetation

This section provides a general discussion of the plant species that occur at NAVMAG PH Lualualei Branch. It includes a summary of the following: (1) vegetation types; (2) endemic species; (3) indigenous species; and (4) alien species.

4.3.5.1 NAVMAG PH Lualualei Branch

The entire NAVMAG PH Lualualei Branch, developed and undeveloped areas, has been surveyed intensively. HNHP classified nine vegetation types at NAVMAG PH Lualualei Branch (HNHP 2004a) (Figure 4-8): (1) Cook Island pine; (2) mixed trees; (3) Christmas berry dominant; (4) transitional koa haole and Christmas berry; (5) koa haole dominant; (6) kiawe dominant; (7) mixed shrub and grass; (8) grass dominant with kiawe; and (9) urban or built up land.

A total of 365 species of vascular plants and ferns have been observed in Lualualei Valley including 133 endemic, 37 indigenous, 181 alien species, and 14 species of unknown origin. Major vegetation types of NAVMAG PH Lualualei Branch are summarized in Table 4-4 and a map is presented in Figure 4-8. Like other lowland areas throughout Hawai'i, much of the vegetation in Lualualei Valley has been considerably altered by human activities, especially by farmers and herders who used much of the lowlands for cattle grazing. Most of the native flora in Lualualei Valley is limited to higher elevations where it is too steep for ranchers to graze their cattle.

Table 4-4: Vegetation Types at NAVMAG PH Lualualei Branch

Dominant Vegetation	Description
Cook Island pine	Cook Island pine dominant (*Casuarina equisetifolia*)
Mixed trees	Higher elevation: mixed native and non-native (no dominant species)
	Lower elevation: mixed non-native (no dominant species)
Christmas berry dominant	Not applicable
Transitional koa haole and Christmas berry	Evenly distributed split between koa haole and Christmas berry dominant species
Koa haole dominant	Not applicable
Kiawe dominant	Not applicable
Mixed shrub and grass	Mixed shrub and grass (no dominant species)
Grass dominant with kiawe	Not applicable
Urban or built up land	Not applicable

Source: HNHP 2004a

Within the administrative and housing areas, there are groves of mature trees that were planted during the installation's initial development to create a more habitable environment. These include monkeypod trees along the historic streets, and shade trees and Norfolk Island pines in lawn areas around the buildings and houses. The lack of trees in the large central lawn of the original administration area is an important characteristic of that space (DON 2008b).

Within NAVMAG PH Lualualei Branch, there are 133 recorded plant species that are endemic to the Hawaiian Islands. Nineteen of these species are also federally-listed endangered species with individuals or small populations that represent a small portion of the species (Table 4-3). Lualualei Valley supports some the largest and most important forests of endemic species including lonomea (*Sapindus oahuensis*) and hame (*Antidesma pulvinatum*) (DON 2001b).

Thirty-seven species of indigenous plants have been recorded in Lualualei Valley; some of these are rare in the Hawaiian Islands and some play an important role in the ecosystem as dominant vegetation: (1) pāpala kēpau (*Pisonia brunoniana*); and (2) 'a'ali'i (*Dodonaea viscosa*) (DON 2001b).

One-hundred eighty-one of the 365 plant species found in the Lualualei Valley are alien or introduced. Purposeful introductions of non-native species by humans prior to European contact are sometimes referred to as Polynesian introduced. Within Lualualei Valley, these include: (1) *kukui* (*Aleurites moluccana*); (2) ti (*Cordyline fruticosa*); (3) taro (*Colocasia esculenta*); and (4) *'ape* (*Alocasia macrorrhiza*). In addition, the Territory (now State) of Hawai'i purposefully introduced several species of trees in 1902 to reforest eroded landscapes. Species include: (1) Eucalyptus; (2) Cook Island pine (*Araucaria columnaris*); (3) ironwood (*Casuarina equisetifolia*); (4) Ficus; (5) logwood (*Haematoxylum campechianum);* and (6) *Peltophorum inerme*. The presence of albizia and silk oak (*Grivellea robusta*) within the installation are the result of the dispersal of introduced species elsewhere (DON 2001b).

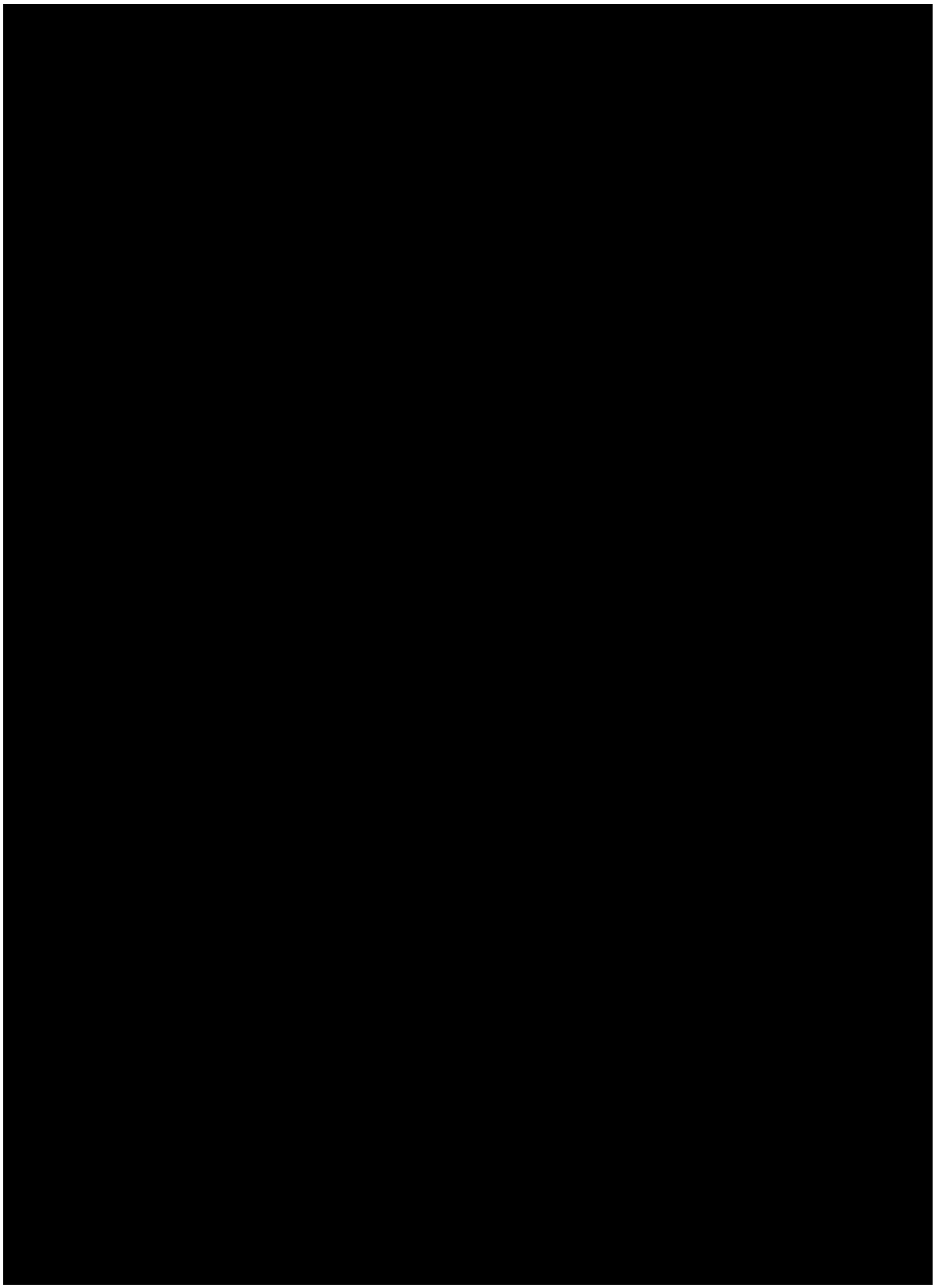


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Figure 4-8: Vegetation, NAVMAG PH Lualualei Branch, Lualualei Study Area

Some alien plants are considered noxious weeds or pests, competing for space and resources with native plants: (1) huehue haole or passion vine (*Passiflora suberosa*); (2) Christmas berry; (3) koa haole; (4) guinea grass; and prickly pear (*Opuntia ficus-indica*) (DON 2001b).

The 2004 HNHP Flora and Fauna Survey of NAVMAG PH Lualualei stated that most of the rare plants in the study area are better represented elsewhere in the Wai'anae Mountains in terms of population, size, population health, habitat quality, and the feasibility of management for conservation. However, for three taxa, the Lualualei INRMP study area is critically important: (1) *Chamaesyce kuwaleana*; (2) *Lipochaeta lobata var. leptophylla*; and (3) *Melanthera tenuis*. The report noted that if rare plant management priorities are set for plants of the Lualualei INRMP Study Area, these taxa deserve top priority. *C. kuwaleana* stands to benefit the most from the implementation of rare plant management measures since the species only occurs in small areas in the study area and on lands bordering Navy lands. Threat from fire is sharply on the rise for this species. In addition, the ongoing spread of Guinea grass and molasses grass contributes to the threat of fire.

4.3.5.2 NRTF Lualualei

A total of 92 vascular plants have been identified at NRTF Lualualei. Of these, five are endemic, seven are indigenous, 80 are alien (introduced intentionally or accidentally by humans after European contact) (HNHP 2004b). Vegetated areas at the installation include: (1) developed and improved areas; and (2) unimproved areas.

1. Developed and Improved Areas

About 90 percent of the 1,700 ac (687 ha) installation is flat-bottomed land with a cover of exotic (primarily buffelgrass) grasses and herbs that require regular maintenance and mowing (Figure 4-9). The expansive carpet of grasses and lack of vertical vegetation of the antenna fields and the grove of trees associated with the inactive historic housing community are character-defining elements of the installation. The broad lawns and mature shade trees create an oasis within the expanse of antenna fields and are significant in that they reflect intentional planting to create more habitable areas for residential use. Large banyan, monkeypod, African tulip, mango, Norfolk Island pine, and coconut palm trees line the streets and are scattered around the homes, with limited foundation planting (DON 2008b). The flat-bottomed grass lands including shrubs among the grasses is kept to a height of 12 in (300 mm) or less.

2. Unimproved Areas

Minor wooded areas composed of alien plant species occur at the north and south corners of the facility. These areas are defined as xero-tropical or dryland sclerophyll forest zones. Such zones are found below 1,000 ft (305 m) elevation and are characterized by annual rainfall of 20 in (50.8 cm) or less, with long, hot, dry summers. It is sometimes referred to as the "kiawe (*Prosopis pallida*) lowland scrub zone" (DON 2001c). Two principal vegetation types comprise the undeveloped portions of NRTF Lualualei: (1) buffelgrass/ kiawe community; and (2) koa haole/kiawe scrub community (Figure 4-9). The buffelgrass/kiawe, covers approximately 60 ac (24 ha) and consists of widely scattered *kiawe* trees in a matrix of buffelgrass and weedy annual species. The koa haole/kiawe scrub covers roughly 110 ac (44.5 ha) and encompasses Niuli'i Ponds Wildlife Refuge. The vegetation is dominated by koa haole and kiawe. The kiawe trees are widely separated with koa haole forming a shrub layer between the trees. A mixture of grass, weedy annual, and smaller shrub species are found beneath the koa haole/kiawe canopy. Other vegetation found surrounding the ponds is almost all alien; native plants include ma'o (*Gossypium tormentosum*), 'ilima (*Sida fallax*), and pā'ū o Hi'iaka (*Jacquemontia*

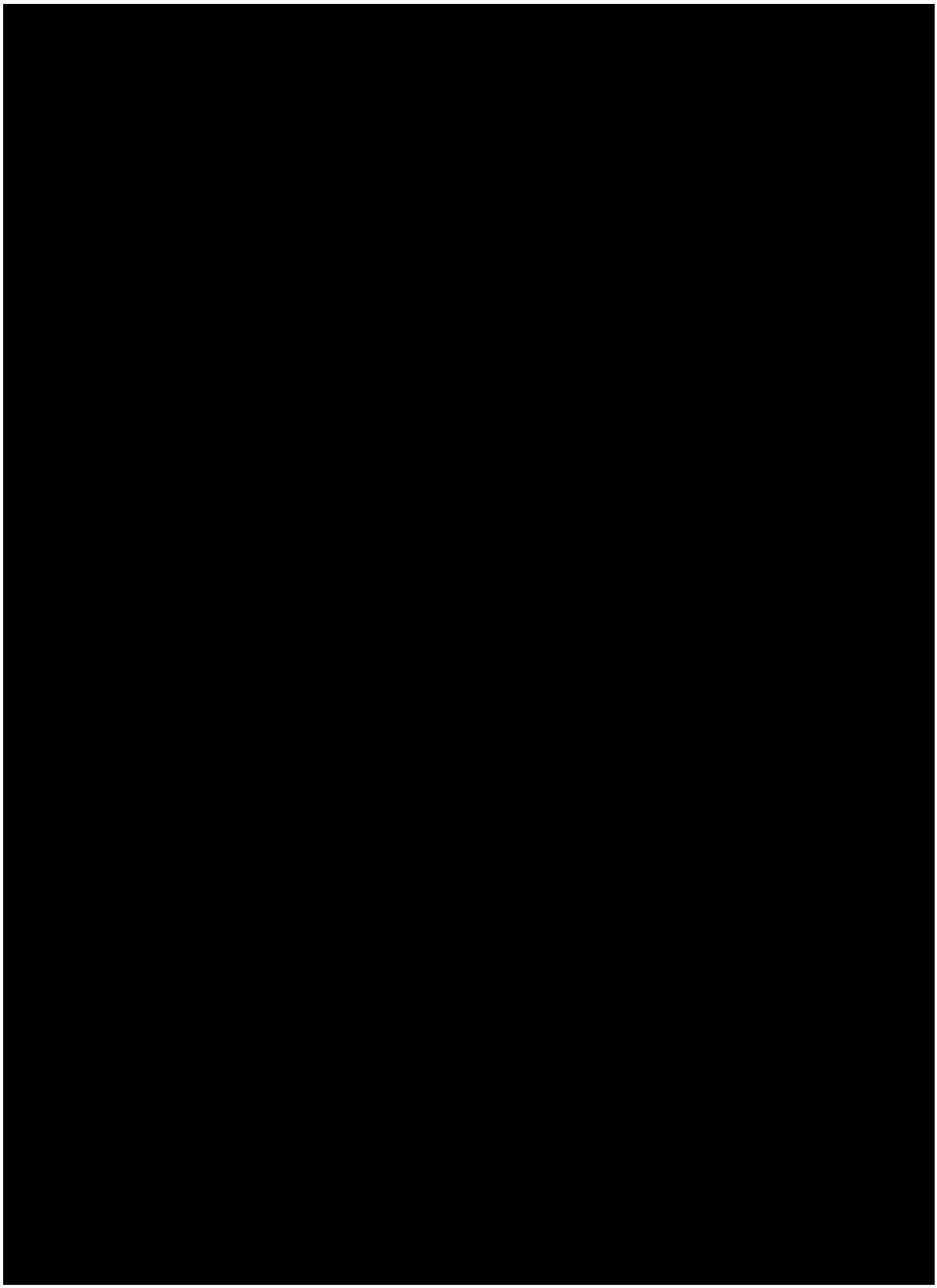

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Figure 4-9: Vegetation, NRTF Lualualei, Lualualei Study Area

sandwicensis). California grass (*Brachiaria mutica*) also surrounds the pond areas (DON 2001c).

Three federally-listed plants are known to occur at NRTF Lualualei: (1) *Marsilea villosa*; (2) *Abutilon menziesii*; and (3) *Cyperus trachysanthos* (Section 4.3.1.2). In addition, Hawaiian cotton or ma'o is found scattered throughout NRTF Lualualei. A large colony is found in the southwestern corner of the installation near the *M. villosa* colony. It is not considered endangered or threatened by the USFWS or the State as the species occurs in lowland areas on all islands. Ma'o is, however, considered depleted by some. This attractive endemic species with bright yellow flowers and bluish-green leaves covered by silvery hairs is easily cultivated. It is found in a number of arboreta and botanical garden as well as in private collections (DON 2001c).

4.4 CURRENT MANAGEMENT

4.4.1 Protected-Species and Ecosystem Monitoring and Management Actions

4.4.1.1 Predator Control

The Navy continues to fund USDA-WS to provide predator control (Photo 4-40) in order to protect ESA-protected bird species at the Niuli'i Ponds Wildlife Refuge. The work involves a trapping operation within the confines of the ponds' enclosure (Appendix D3 [Figure 23]). The traps are checked every 48 hours and all animals caught are recorded (Appendix D3 [Table 1]). Table 1 of Appendix D3 covers the period of 2004-2005. Other data was not available.

Photo 4-40: small mammal cage used for predator control at Niul'i Ponds Wildlife Refuge

Cattle egrets predate on Hawaiian black-necked stilt chicks and control of cattle egrets near refuges has been effective in improving the nesting success of stilts. Control of cattle egrets at the refuge began in 2001 and again in late Spring of 2005 after large numbers of cattle egret were recorded (NAVFAC PAC 2006c).

In order to reduce mortality risk, active predator control occurs at the five known 'elepaio territories in NAVMAG PH Lualualei during the breeding season. Personnel from USDA-WS report that rat density at these territories is potentially very high if estimates are based on the amount of bait taken (HNHP 2004a). In addition, rat control occurs within the upper reaches of Lualualei Valley to control predation of protected and/or rare snail species.

4.4.1.2 Protected Species Monitoring and Reporting

1. Hawaiian Waterbirds

The Navy maintains and manages the Niuli'i Ponds Wildlife Refuge which provides habitat to federally-listed endangered Hawaiian waterbirds (Hawaiian black-necked stilt, Hawaiian common moorhen, Hawaiian coot, and Hawaiian duck). NAVFAC PAC completed a report on waterbirds of Niuli'i Ponds in 2006 (NAVFAC PAC 2006c). The survey results are summarized in Section 4.3.1 and the survey is presented in its entirely in Appendix D3. As discussed in Section 4.4.1.1, the Navy funds predator control in order to protect waterbirds at Niuli'i Ponds.

Section 9.5 provides recommendations for the continued management of the refuge, predator control, and survey updates.

2. O'ahu 'Elepaio

The Navy orchestrated past surveys for the ESA-protected O'ahu 'elepaio in order to proactively manage this species (NAVFAC PAC 2003e; HNHP 2004a; NAVFAC PAC unpublished data). Population levels ranged from five in 2003, four in 2005, two in 2006, and none in 2007. It is likely that a combination of factors, including habitat loss, competition from non-native birds, mosquito-borne avian disease, and predation from introduced mammalian predators has contributed to the decline of this species at NAVMAG PH Lualualei. In order to reduce mortality risk, active predator control was conducted at known 'elepaio territories in NAVMAG PH Lualualei during the 2004 breeding season. Personnel from USDA-WS report that rat density at these territories is potentially very high if estimates are based on the amount of bait taken (HNHP 2004a). Section 9.5 provides recommendations for a long-term management plan and play-back surveys for the O'ahu 'elepaio.

3. Hawaiian Short-eared Owl

No management requirements, goals, and objectives have been identified for the Hawaiian short-eared owl.

4. Hawaiian Hoary Bat

There are no current management actions for the Hawaiian hoary bat at Lualualei. Recommendations are made in Section 9.5 to conduct monitoring surveys to detect presence/absence of the animals on Navy lands.

5. *Amastra Cylindrica*

NAVFAC PAC conducted a survey of snail fauna of Lualualei Valley in 2006. The greatest threats to populations of *A. cylindrica* at Pu'u Hāpapa are predation from rodents and habitat degradation from invasive weeds. CNRH has funded a predator control program at Pu'u Hāpapa and has provided additional funds for snail monitoring and habitat improvement. Baiting and trapping of rodents at Pu'u Hāpapa for a period of one year was contracted and initiated in March 2007. NAVFAC PAC biologists continue to monitor the population of *A. cylindrica* and provide control of invasive weeds in the area (NAVFAC PAC 2007b). Section 9.5 presents recommendations to increase rat control efforts, predatory snail control, and conduct a feasibility study to translocate snails to an additional pisonia grove and/or increase the size of the pisonia stand through selective thinning of Christmas berry trees and pisonia seedling outplanting.

6. *Achatinella mustelina*

NAVFAC PAC conducted a survey of snail fauna of Lualualei Valley in 2006. The greatest threats to populations of *A. mustellina* at Pu'u Hāpapa are predation from rodents and habitat degradation from invasive weeds. CNRH has funded a predator control program at Pu'u Hāpapa and has provided additional funds for snail monitoring and habitat improvement. Baiting and trapping of rodents at Pu'u Hāpapa for a period of one year was contracted and initiated in March 2007. NAVFAC PAC biologists continue to monitor the population of *A. cylindrica* and provide control of invasive weeds in the area (NAVFAC PAC 2007b). Section 9.5 provides recommendations for snail population monitoring and conducting predator control.

7. NAVMAG Candidate/Proposed insects (Megalagrion, Yellow-faced Bees, Drosophila)

In 2006, NAVFAC PAC biologists conducted arthropod surveys at Hālona Valley and surveyed for endemic Hawaiian damselflies at Pūhāwai Falls (Section 4.3.4.5). Although no listed insects have been found at Lualualei, and no insect critical habitat currently exists at Lualualei, several taxa are proposed for listing that may be present or were historically present at Lualualei. Therefore a discussion of management actions is warranted and recommendations are made in Section 9.5.

8. NAVMAG PH Lualualei Listed/Candidate/Species of Concern Plant Species

The Navy conducted its existing conservation mapping at Lualualei in order to expand its database on potential listed species at the installation. Under an Endangered Species Recovery Permit from USFWS, Navy biologists opportunistically collect plant material (cuttings and seeds) from federally-listed plant species. These materials are provided to Lyon Arboretum or other researchers for use in propagation and outplanting, research, and genetic storage. Many Lualualei protected plant populations (e.g., *A. sandwicense, Cyperus trachysanthos, M. villosa, A. menziesii)* have not been represented in the Lyon Arboretum storage facility before this permit was obtained in 2005 (NAVFAC PAC 2006e). Focused protection of endangered plants includes weed control immediately surrounding the plants to limit interference competition. An MOU between the Navy and the Army for the Army to perform conservation work as required by their Makua Implementation Plan is ready to be signed by the Joint Base Commander. This will allow some protection of listed species through Army management actions. The unsigned MOU is attached as Appendix I14.

Hālona Exclosure. At the Hālona exclosure, a Navy contractor has been working to remove invasive species since 2002 and has followed a Navy-prescribed restoration plan in the exclosure. Passion flower and coral berry have been removed and outplanting of native species has occurred. Fourteen new *A. sandwicense* (a federally-listed endangered species) have emerged in the Hālona exclosure. Strong natural recruitment of native species has occurred. A catchment system was installed in 2006 to assist with outplanted seedlings. Navy biologists and contractors have tagged all of the listed plants and monitor them on a regular basis (NAVFAC PAC 2006e).

Pu'u Hāpapa Exclosure. Navy biologists and contractors have tagged all of the listed plants the Pu'u Hāpapa Exclosure and monitor them on a regular basis (NAVFAC PAC 2006e). Navy biologists provide field support to Army environmental biologists from Schofield Barracks in obtaining cuttings and seeds from threatened and endangered plants in Lualualei as outlined in the Army's *Makua Implementation Plan.* Collections have been obtained from all *F. neowawraea* trees and all of the *Neraudi angulata* plants, which are federally-listed endangered species that are within reach (NAVFAC PAC 2006e).

9. *Abutilon menziesii*

A. menziesii, a federally-listed endangered species, has only recently been recorded growing wild on the island of O'ahu. The plants at Lualualei are the only wild *A. menziesii* plants discovered thus far on O'ahu aside from plants in the 'Ewa Plains area; its genetic material may be important for the conservation of the O'ahu population of the species. Material from these plants has been collected by NAVFAC PAC biologists and propagated by DLNR staff. A thick layer of tall grass that surrounds the plant likely precludes the successful recruitment of seedlings and increases the risk of the plant being killed by a brushfire (HNHP 2004b). Monitoring occurs year round to document its seasonal and reproductive stages. Seeds are also collected for genetic storage. NAVFAC PAC biologists provide seeds to Lyon Arboretum

for storage. NAVFAC PAC biologists trim back encroaching kiawe branches in order to avoid negative impact to the *A. menzeiesii*. NAVFAC PAC biologists apply insecticide when predation from insects is severe (NAVFAC PAC 2006e). Section 9.5 provides a recommendation for a project for signage and fencing and describes projects for annual monitoring and control of invasive kiawe and buffelgrass adjacent to the plants.

10. *Marsillea villosa* and *Cyperus trachysanthos*

M. villosa. NAVFAC PAC Natural Resources staff have researched and implemented a management strategy for *Marsilea villosa,* a federally-listed endangered species. Signs have been placed in the areas where this ESA-protected plant species occurs and mowing schedules have been revised to protect the plant.

The NRTF Lualualei *M. villosa* populations are delineated with signage and removable posts to avoid inadvertent negative impacts (e.g. mowing when still flooded, construction impacts, vehicle traffic, etc.) to the plants. The contracted landscaping crew has been educated about the mowing restrictions and follow an SOP (Appendix I15, Mowing Endangered Plants at Lualualei)

Unauthorized ground clearing and accidental intrusion into the area by off-road vehicles could threaten the well-being of the *M. villosa* colony at NAVMAG PH Lualualei. The lessee has been directed not to disturb the site in anyway beyond the terms of the lease. The Navy monitors the colony to ensure its protection and after heavy rains to determine if the colony has survived the drought conditions that have persisted in the area in recent years.

C. trachysanthos . All of the *C. trachysanthos* (a federally-listed endangered species) populations at NRTF Lualualei have been tagged. An ESA consultation with USFWS allows the Navy to mow the *C. trachysanthos* populations, if necessary, after they have dropped at least 50 percent of their seeds. The plants are regularly monitored by NAVFAC PAC biologists and the installation staff is advised when mowing is approved (NAVFAC PAC 2006e).

4.4.1.2 Access Restrictions

The Lualualei INRMP Study Area is a restricted area due the presence of ordnance and munitions and related health and safety concerns (ESQD arcs, EMR) and, therefore, access to areas with significant natural resources, including protected species, is limited to authorized personnel. These restrictions provide a measure of protection to these species and their habitats.

4.4.1.3 Invasive Species Prevention and Control

The Navy continues to monitor and control feral ungulates in the upper portions of Lualualei Valley. This includes maintaining barrier fencing at the Hālona and Pu'u Hāpapa exclosures (Section 4.4.1.2) in order to protect native plant habitats and monitoring the impact of feral ungulates on native plant habitat. In addition, the NAVFAC PAC Natural Resources staff continues to control invasive plant species in protected areas. Section 4.4.1.1 provides a discussion of predator control at the Lualualei INRMP Study Area.

4.4.1.4 Natural Resources Restoration

NAVFAC HI Storefront Environmental Coordinators coordinate with USFWS and DOFAW with regard to natural resources enhancement projects aimed at the preservation of ESA-protected plant and animal species at the Lualualei INRMP Study Area.

4.4.1.5 Wetlands

NAVFAC HI Storefront Environmental Coordinators ensure that there is no net loss of wetlands on Navy-controlled lands, while simultaneously establishing and/or enhancing native wetland species and reducing alien wetland species. The Navy provides for formal wetland training for CNRH, NAVFAC Hawaii, and NAVFAC PAC natural resources and environmental staff.

Maintain Wetland Habitat at Niuli'i Ponds

NAVFAC PAC has implemented a management plan for the Niuli'i Ponds (Appendix I11) and continues to maintain wetland habitat at the Niuli'i Ponds Wildlife Refuge in order to preserve, protect, and enhance wetlands and protected bird species that inhabit them. NAVFAC PAC biologists have conducted surveys at the ponds from October 2002 to September 2003, January 2004, August 2004 to October 2005, and December 2005.

In 2005, the Navy connected a freshwater line (from an existing waterline) with a manual outlet that connects the pump to Pond 1 (NAVFAC PAC 2006c). Pond water is kept to a level to cover at least the entire base of Pond 1, with deeper water in the center of the pond maintained at a deeper level to provide foraging habitat for Hawaiian coots.

NAVFAC PAC biologists continue to manage vegetation to maximize nesting success, brood survival, food availability, and recruitment of waterbirds at the ponds. Fencing at the ponds was installed in the 1990s, predator control began in 1994, and cattle egret control began in 2001. Human disturbance of the waterbirds using the ponds is minimized by the exclusion fencing/ gate and posted signs. Furthermore, entry is limited to authorized personnel. NAVFAC PAC biologists monitor for avian disease at the ponds and groundskeepers notify biologists or natural resources personnel of noticeable and different occurrences regarding any birdlife. The Navy minimizes contamination of waterbird habitat by toxic substances through the implementation of an Integrated Pest Management Plan (2003) to control pesticide use on the base. Additionally, the refuge is not located near areas where pesticides or other toxicants or pollutants are used. NAVFAC PAC biologists monitor all populations of endangered waterbirds at the ponds on a semi-regular basis using standardized surveys (NAVFAC PAC 2006c).

4.4.2 Natural Resources Surveys

The Navy updated botanical surveys, including ESA-protected species, at Lualualei between 2003 and 2006 (Section 4.3). The results of these surveys were used by NAVFAC PAC Natural Resources staff to develop a prioritized listing of species for monitoring and the implementation of recovery actions (Section 9.5).

The Navy updated animal surveys, including ESA-protected species, at Lualualei between 2003 and 2006 (Section 4.3). The results of these surveys were used by NAVFAC PAC Natural Resources staff to develop a prioritized listing of species for monitoring and the implementation of recovery actions (Section 9.5).

In 2006, NAVFAC PAC biologists conducted arthropod surveys at Hālona Valley and surveyed for endemic Hawaiian damselflies at Pūhāwai Falls (Section 4.3.4.5).

The Navy expanded its existing conservation mapping at Lualualei in order to expand its database on potential listed species at the subinstallation.

The Navy completed surveys for the ESA-protected O'ahu 'elepaio to proactively manage this species (NAVFAC PAC 2003e).

4.4.3 Use of Geographic Information Systems

As discussed in Section 2.4, the installation's natural resources data is continually being integrated into the installation's GIS system and made available to planners and land managers to aid in decision-making. The NAVFAC HI Storefront Environmental Coordinators and NAVFAC PAC Natural Resources staff ensure that newly acquired or updated natural resources information is integrated into the installation GIS database on a regular basis. NAVFAC PAC has created GIS layers in geodatabase format for Lualualei for the following data: (1) fauna habitat; (2) fauna special species areas; (3) wildlife management areas; (4) flora special species areas; and (5) land vegetation cover.

4.4.4 Forestry

There are no significant commercial forestry resources at the Lualualei INRMP Study Area. The forestry plantings within the installation occupy an area too small to warrant a timber management program for commercial production on a long-term, sustainable-yield basis. In addition, the forests are confined to wetter areas at the foot of the Wai'anae Mountain Range. Slopes in these areas are generally greater than 20 percent. These forestry plantings function primarily to adhere soil to the plants in order to prevent erosion. Native snails and insects are associated with these mixed forest areas.

Plots of forestry plantings and mixed forests of native and introduced forestry tree species can be found on the slopes below Kolekole Pass, Pōhākea Pass, and Pu'u Hāpapa. Forestry plantings include eucalyptus, Australian red cedar (*Toona ciliata)*, silk oak, logwood (*Haematoxylon campechianum)*, ironwood, Cooke pine, and Norfolk pine. There are numerous pocket (less than 5 ac [2 ha]) native forests at higher elevations within the subinstallation. These native forest communities are incompatible with land that has been radically altered and cleared. Native species occasionally found on the steep slopes and occurring among the forestry plantings include wiliwili, alahe'e, lonomea, olupua, hao, and sandalwood.

Large portions of the subinstallation are covered by koa haole scrub with scattered kiawe trees. In low lying areas and in drainage areas along the western portion of NAVMAG PH Lualualei Branch, in broad flat areas north of Kolekole Pass, and in two areas within NRTF Lualualei, kiawe trees are more numerous.

4.4.5 Community Outreach

The Lualualei INRMP Study Area is a restricted area due the presence of ordnance and munitions and related health and safety concerns (ESQD arcs, EMR) and, therefore, community outreach activities are not permitted.

4.4.6 Outdoor Recreation

The Lualualei INRMP Study Area is a restricted area due the presence of ordnance and munitions and related health and safety concerns (ESQD arcs, EMR). Recreation opportunities may exist but need to be balanced with those safety concerns.

4.4.7 Land Management

Ongoing land management programs at the Lualualei INRMP Study Area are similar to those discussed in Section 3.4.7. They include base planning, reduction of point source pollution, utilization of BMPs during earthwork and construction and storm drain design, non-point source pollution prevention for JBPHH. In addition, at the Lualualei INRMP Study Area, the Navy continues maintenance, management, and enhancement of areas with natural resource value and management of grasses and vegetation in antenna fields.

Environmental reviews of all facilities and operations projects are conducted to ensure compliance with land management best practices, such as directing impacts of activities away from sensitive habitats and siting new facilities in already developed areas, when appropriate. The Navy continues to preserve, protect, and enhance wetlands at the Lualualei INRMP Study Areas (Section 4.4.1.6). The Navy continues to promote soil stability and control soil erosion in exclosure areas.

4.4.7.1 Support and Protect Native Plant Species

The Navy has supported the growth and survival of native plant species within the Lualualei INRMP Study Area by constructing fenced exclosures to exclude feral ungulates (Section 4.4.1.2). NAVFAC PAC Natural Resources staff continue to control invasive weeds in higher elevation management areas in order to support growth and survival of native plants. Active feral ungulate management is ongoing in order to protect native plants and habitats.

4.4.7.2 Use of Native Plants in Landscape and Enhancement Projects

As discussed in Section 3.4.7, the Navy continues to utilize native plants in landscape and enhancement projects at the Lualualei INRMP Study Area.

4.4.7.3 Grass Maintenance in Antenna Fields

The Navy continues to provide maintenance of grasses in antenna fields in order to support the military mission and the presence of *Marsilea villosa* (Section 4.4.1.2).

4.4.8 Floodplains

The majority of the Lualualei INRMP Study Area is located in an area of undetermined but possible flood hazard (Zone D). A small portion of Māʻiliʻili Channel and Māʻiliʻili Stream located on the northwest side of NRTF Lualualei is designated as a special flood hazard area which is prone to inundation during a 100-year flood (FEMA 2011). The Māʻiliʻili and Māʻili Streams (Figure 4-3) have a common flood plain in the coastal zone below the 25 ft (8 m) notch. Extensive flooding occurs downgradient from NRTF Lualualei when coastal sand berms form across the channel mouths.

4.4.9 Law Enforcement

The Lualualei INRMP Study Area is a restricted area policed by the Base police.

4.4.10 Wildland Fire

Wildland fires have not impacted the Lualualei INRMP Study Area in recent years; however, the disturbed land on the leeward coast of the Wai'anae Mountain Range are dangerously prone to brush fires. Many alien grasses such as buffelgrass are dry and extremely flammable. In addition, koa haole and Christmas berry form dense forests where dry debris and dead material provide fuel for fires. The Navy currently maintains grasses and vegetation within the developed portions of the subinstallation. The FFD would respond to any fires at the subinstallations and may request support from the CCH Fire Department and DLNR. The Federal Fire Department at Lualualei currently coordinates with the O'ahu Wildland Fire Council to ensure that fuel breaks, water sources, fire prevention measures, and fire suppression staffing are adequate to ensure the activities at the Lualualei INRMP study area minimize the potential for wildland fire impacts to listed species. However, there may not be a clear leadership structure or operational plan to respond to a wildland fire at Lualualei. Section 9.5 provides a recommendation for a wildfire management plan which would be developed to minimize the risk of a wildfire and to develop a framework for swift and effective response in the event of a wildfire.

4.4.11 Leases and Encroachment Management

The Navy continues to monitor surrounding property development in order to limit encroachment to ensure the continued military mission of the subinstallations and protect natural resources. An Encroachment Management Plan was developed by Navy Region Hawaii to identify at an early stages potential community development, or changes in local laws/regulations that may affect Navy operating procedures (Navy Region Hawaii 2010).

4.4.11.1 NAVMAG PH Lualualei Branch

There were two lease areas at NAVMAG PH Lualualei totaling 631 ac (255 ha) and another 507 ac (205 ha) area with potential use for grazing.

Lease Area #1 was comprised of 420 ac (170 ha), known as Navy Lease N6274279R00060, which was with Mr. Patrick D. Pauline, dba Tri-Angle Ranch. The lease began 1 October 1979 and was continued as a holdover since 1984, and will be terminated on 30 September 2011. It covered two parcels on the western side of the facility, both of which were cleared, had water available, and were rated fair to good for grazing. Improvements on the land belonged to the lessee. Rent was at the rate of $2,310.00 per year with payments made on a quarterly basis. Rent credit was available provided for government-directed improvements and/or soil conservation. Permitted stocking of grazing areas was one animal per 5 ac (2 ha) (DON 2001b). All cattle have been removed by the lessee.

Lease Area #2 was comprised of 211 ac (85.4 ha), known as Navy Lease N6274297RP00041, which was with Mr. Wayne Costa dba Wayne's Dairy. The lease began on 1 November 1997, was on holdover since 2001, and was terminated in 30 November 2006 (NAVFAC PAC 2008b). The parcel is located at the northwestern sector of the installation and is situated between Lease Area #1 and the boundary of the installation. Rent was at the rate of $4,725.88 per year and paid on a quarterly basis, in advance. There is no on-site source of water to adequately

support the grazing operation. The lessee was trucking water into the grazing lot. Permitted maximum stocking of grazing area was 300 animals per 5 ac (2 ha) (DON 2001b).

There is a 507-ac (205-ha) lot located on an upper portion of developed areas in the southeastern portion of the installation that is a potential lease area. Prior to 1992, the lot was leased for cattle grazing. However, fences were not maintained by the lessee resulting in the release of more than 30 cattle escaping to the forested slopes of Lualualei. The cattle were recaptured. After several warnings, the lessee was ordered to leave the lot in 1992. Prior to the removal of the lessee and termination of the lease, the area had been cleared of undergrowth, water was available, and grazing potential was rated fair to good. Improvements include exterior fencing along the road, dividing fencing, a large open tank group, two storage areas for trucks, corrals, and storage shed. Permitted stocking of grazing areas is one animal per 5 ac (2 ha) (DON 2001b).

4.4.11.2 NRTF Lualualei

Although most of the land at NRTF Lualualei is open and suitable for grazing purposes, currently, there are no agricultural outleases. Two parcels comprising 234 ac (95 ha) at NRTF Lualualei were used for cattle grazing prior to 1992, but are no longer in use. One was located on the eastern border and the other was located in the northwest corner of the installation. The grazing lease on the eastern border was closed to protect the wildlife refuge and the habitat of ESA-protected waterbird species. The grazing lease at the northwest corner was closed to protect a large population of the ESA-protected waterfern, *Marsilea villosa* (DON 2001c).

Portions of the installation are suitable for the production of truck crops and/or livestock forage (grazing). However, not all of the land suitable for grazing purposes can be used as cropland. The very limited water holding capacity of the Mamala soil and shallow rooting depth allow only very limited growth on the large coral plain that occupies much of the area. Without adequate water, truck crops are not feasible and the value of the possible cropland acreage would be significantly reduced.

The primary limitation imposed on crop production is the amount of available water. Groundwater irrigation is not a suitable solution because the quality of the water from the brackish transition zone of the water lens in the alluvium is not satisfactory. Further, though high value truck crops have been grown on Pūlehu soils of the river terrace, the threat of serious flood every five years makes use of these soils not advisable for crops. Finally, the shrinking and swelling of the highly plastic clays of the Lualualei vertisols make tillage very difficult for any conventional crop.

The areas of Hale'iwa soils have insufficient growth sustaining productivity potential without irrigation. However, during the winter rainy season, the area would provide adequate seasonal grazing pasture. Grazing land requires the least amount of water.

Rain-fed grass could be grown on the flat Lualualei and 'Ewa soils for pasture, and temporary ponding of water from heavy winter storm rainfall could be tolerated by the grass and would not preclude grazing. Growth from seepage into these wetland soils should prolong the period of grazing further into the dry summer and help fill a need suggested by shifts from agricultural to urban use on the Wai'anae coast.

CHAPTER 5

NCTAMSPAC WAHIAWA

CHAPTER FIVE: NCTAMSPAC WAHIAWA

5.1 CURRENT CONDITIONS AND USE

5.1.1 Installation Information

The NCTAMSPAC Wahiawa INRMP Study Area includes NCTAMSPAC Wahiawa and the Camp Stover family housing community. NCTAMSPAC Wahiawa is the name given to the Navy's computer and telecommunications area master station located on approximately 700 ac (283 ha) north of the town of Wahiawā within the central (Schofield) plateau region of O'ahu, Hawai'i (Figure 5-1). Camp Stover Housing Community, located approximately 3.25 mi (5.2 km) southwest of NCTAMSPAC Wahiawa, is comprised of 40 ac (16 ha) adjacent to Wheeler Army Airfield in Central O'ahu (Figure 5-1).

5.1.1.1 General Description

1. NCTAMSPAC Wahiawa

NCTAMSPAC Wahiawa (Photo 5-1) provides radar tracking and surveillance, global position system data processing, the communications network, and command and control from the Range Operations Center. COMPACFLT provides operational direction and control and delegates day to day operational unit control to NCTAMSPAC. NCTAMSPAC, in turn, provides operational direction for subordinate commands within their area of responsibility. NCTAMSPAC reports to Naval Network and Space Operations Command for naval communications matters, and to CNRH for local coordination. Since 1 January 1995, NCTAMSPAC also manages administrative and fiscal issues for Pacific Regional Commands (CNRH 2006).

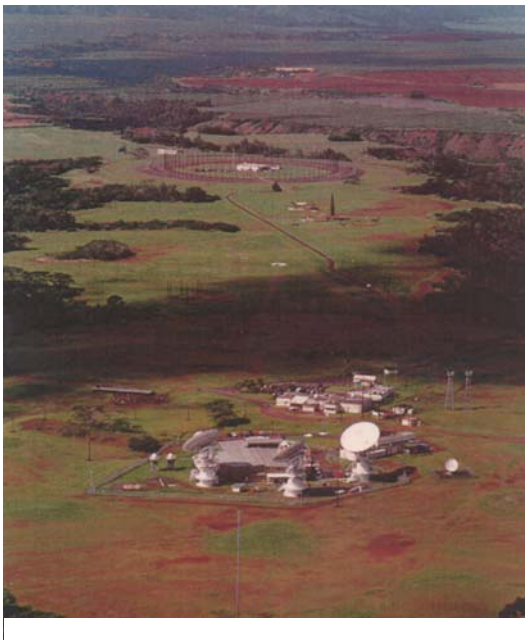

Photo 5-1: NCTAMSPAC Wahiawa

In addition, Hawaii Regional Security Operations (HRSOC) is planning to relocate to NCTAMSPAC Wahiawa and is in the process of constructing new facilities including an operational control center. HRSOC's mission includes intelligence and data gathering and analysis and security operations in the Pacific area.

2. Camp Stover Housing Community

A PPV entity operates and maintains 200 FHU and associated residential amenities including landscaped areas at Camp Stover Housing Community (Photo 5-2). FHU at Camp Stover Housing Community were originally built in 1973 and 110 FHU have been revitalized in recent years.

Photo 5-2: Camp Stover Housing Community

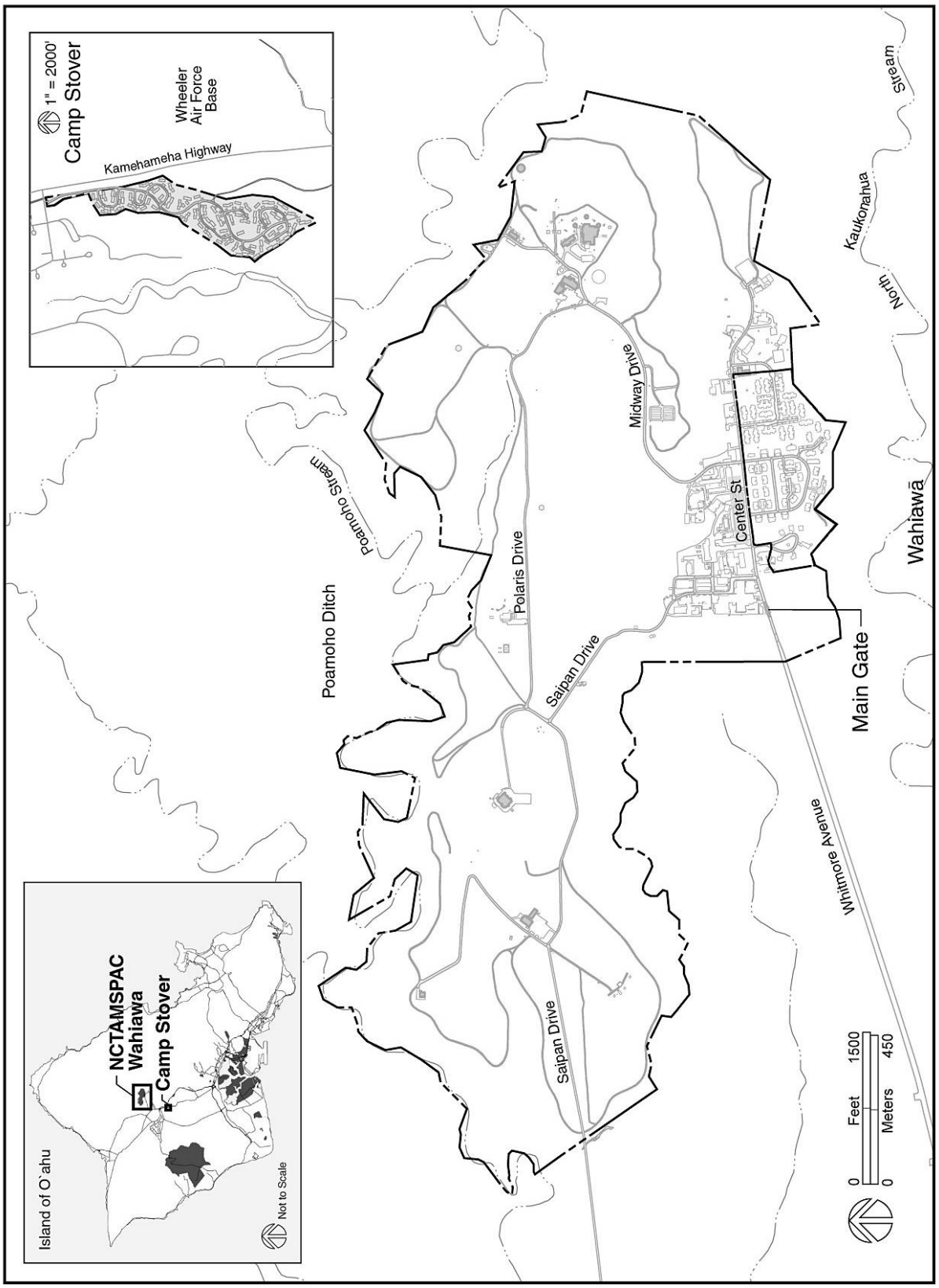

Figure 5-1: NCTAMSPAC Study Area

5.1.1.2 Land Use Constraints

1. NCTAMSPAC Wahiawa

Environmental land use constraints at NCTAMS PAC Wahiawa are defined by the presence of native mesic forests; presence of HLMG soil (Helemano silty clay, 30 to 90 percent slopes), which is characterized by severe to very severe erosion hazard; and steep topography in the bordering gulches (north fork of Kaukonahua Stream to the south and Poamoho Stream to the north). NCTAMSPAC Wahiawa is further divided by a small gully that separates the operations and community area on the south from the antenna fields on the north (Figure 5-2).

Military land use constraints at NCTAMS PAC are defined by the operations and the facilities that serve them. The military operations and training missions at NCTAMSPAC Wahiawa create potential threats to public health and safety including: radio frequency interference (RFI) and EMR. RFI-free zones around receiving antenna are required to prevent interference with the receiving capabilities of the antennas. Some degree of control, either through outright ownership or restrictive easements, must be exercised over land use and any potentially adverse activity in the areas within 1 mi (1.6 km) of general purpose receiving antennas (DON 2001c).

Radio transmitters may radiate high levels of energy that are Hazards of Electromagnetic Radiation to Personnel (HERP), and ordnance (HERO) or may disrupt the operation of nearby electronic equipment, such as television receivers. To ensure that high-density electromagnetic power will not constitute a hazard, EMR zones are designated around transmitter sites. Land uses within 1 mi (1.6 km) of low frequency and very low frequency transmitting antennas and within a 0.5 mi (0.8 km) radius of high frequency transmitting antennas should be controlled to preclude problems with EMR (DON 2001c). In addition, encroachment/AT/FP has been an issue at NCTAMSPAC Wahiawa. The front gate was moved several hundred feet west in recent years to provide an AT/FP buffer zone.

2. Camp Stover Housing Community

The only natural resources land use constraints identified at Camp Stover are the steep topography and the severe to very severe erosion hazard associated with HLMG soils in the gulch bordering the housing community. No military mission land use constraints were identified for the housing community.

5.1.1.3 Land Use Opportunities

No military mission training land use opportunities were identified at the NCTAMSPAC INRMP Study Area.

5.1.1.4 Operations and Activities

Facilities at NCTAMSPAC Wahiawa consist of operations and community support facilities including communications receivers, bachelor and family housing, a Navy Exchange and Shopette, a gymnasium, a youth center, a fitness center, a soccer field, and a movie theater (Figure 5-3). Camp Stover contains 200 FHU, community recreational facilities, parking areas, and landscaped areas.

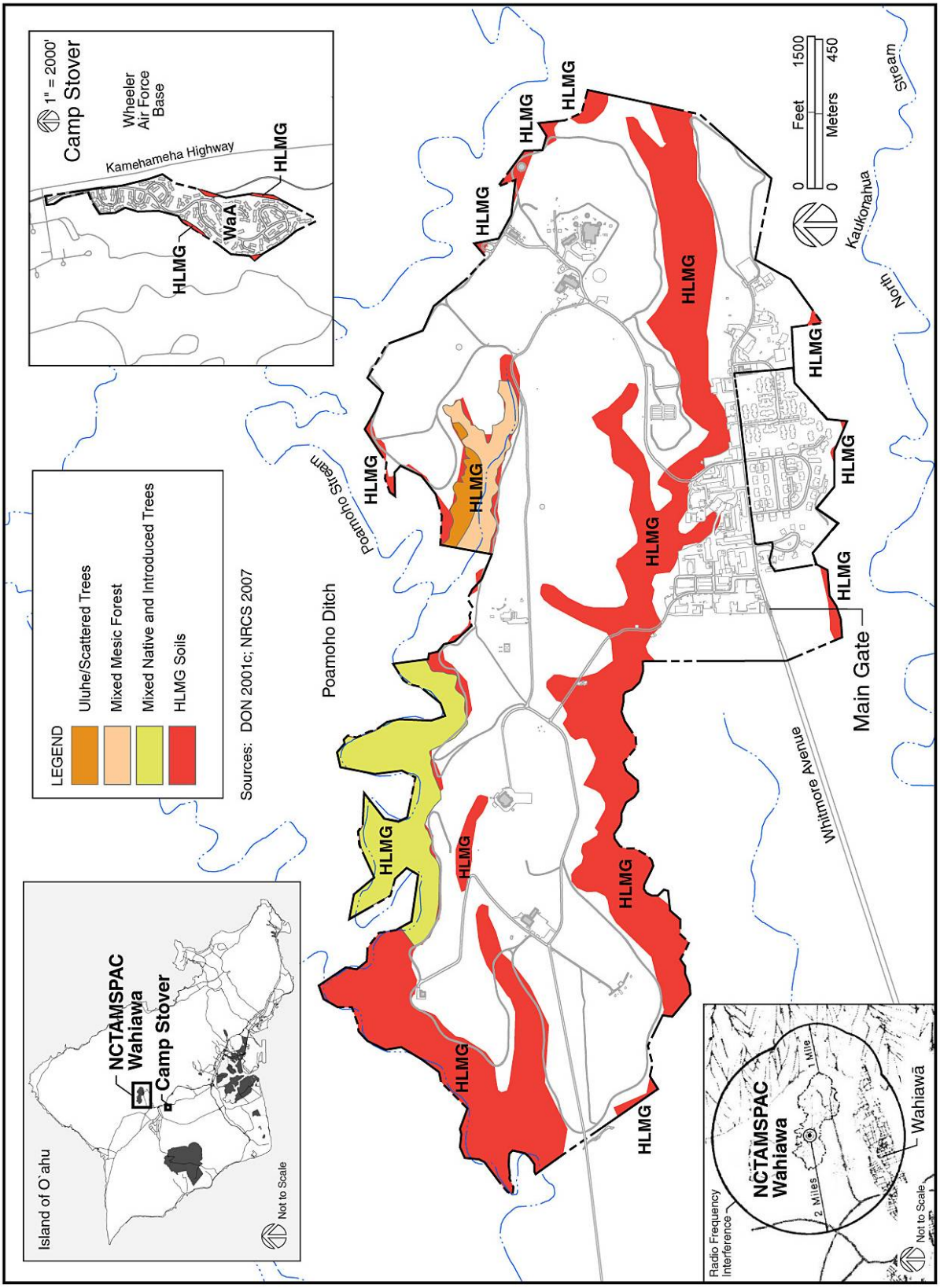

Figure 5-2: Constraints, NCTAMSPAC Study Area

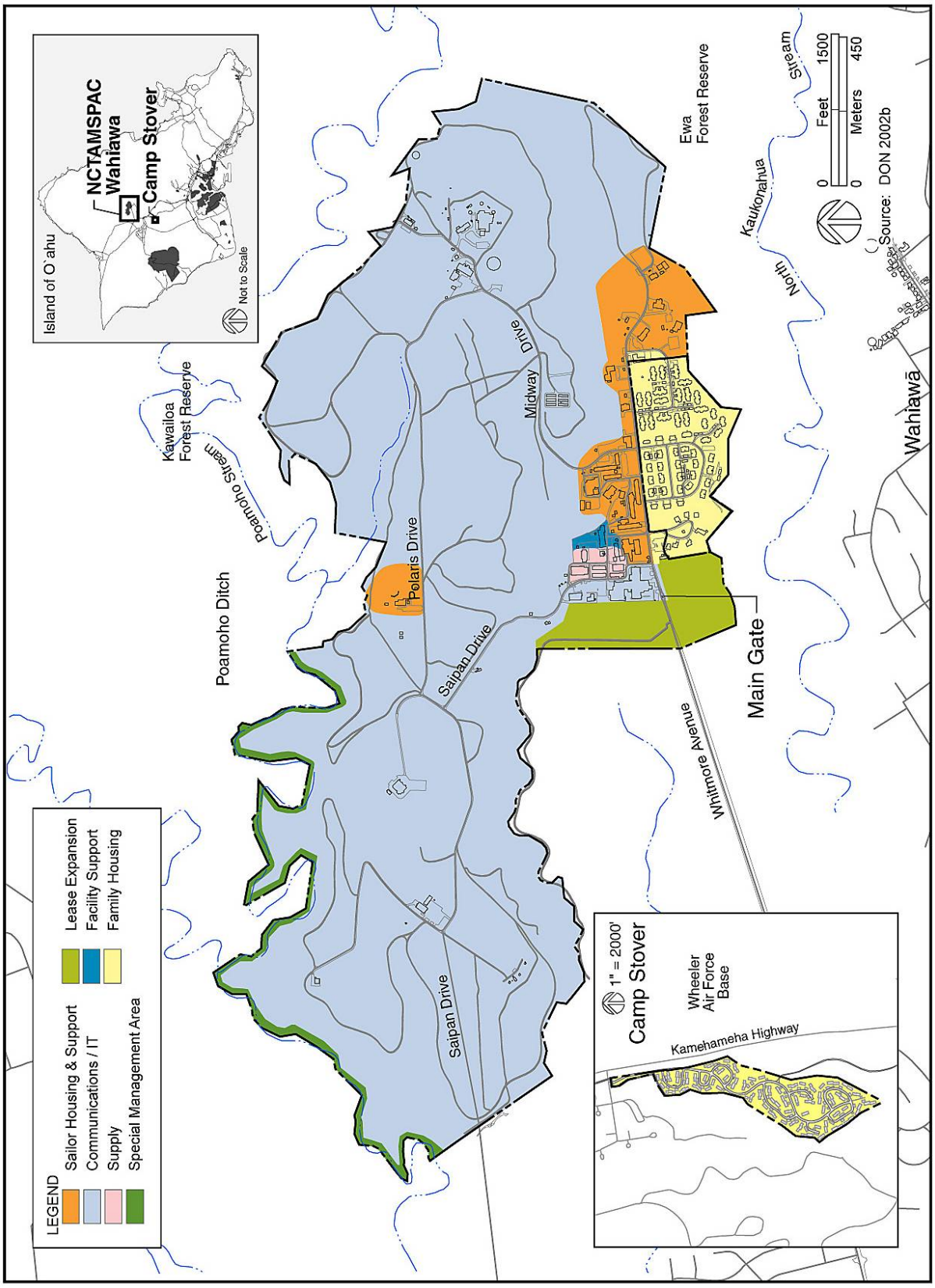

Figure 5-3: Land Use, NCTAMSPAC Study Area

5.1.1.5 Abbreviated History and Pre-Military Land Use

The Wahiawā District was formed in 1913 by the Territorial Government by combining the upper portion of Kamananui ahupua'a with the Wai'anae Uka ahupua'a. It was known as the home of chiefs. The central plateau of O'ahu was once forested with sandalwood and other plant species that were depleted by logging in the early 19th century. The plateau also supported both dry land yam and sweet potato cultivation on the ridges and taro cultivation in lo'i (irrigated terraces) constructed in gulches. Agricultural terraces are reported to have been located along the Poamoho, Helemano, and Kaukonahua Streams as well as on the broad interfluves above the gulches. Residential sites are reported on level lands in interfluvial plateaus (DON 2008b).

During the historic era, commercial agriculture transformed the physical and the cultural landscape of the central plateau. By the 1830s, the land was nearly treeless, with scattered ti plants and small groves of koa. After the Great Mahele in 1848, the entire ahupua'a of Kamananui was designated "Government Land." Homesteads were initiated in the late 1890s, but soon afterwards, James B. Dole began converting the plateau to pineapple cultivation.

1. NCTAMSPAC Wahiawa

The area now known as NCTAMSPAC Wahiawa was used for pineapple cultivation until it was acquired by the Navy for development of a radio transmitter facility in 1940 (DON 2008b). With the arrival of the major COMPACFLT units at Pearl Harbor in 1939, the Navy felt that a new receiver and control station was needed. A secluded spot in Wahiawā, some 20 mi (32.2 km) north of Pearl Harbor, was selected, and purchased by the Navy for approximately $1,000,000. The NCTAMSPAC Wahiawa site was amassed from three parcels of land acquired through different condemnation proceedings beginning in 1940 and ending in 1946 (DON 2008b).

Construction of the installation began in 1940; its construction and the relocation of functions from Wailupe to Wahiawā were completed in December 1941. The new receiving area site was considered excellent and the best-protected radio station on the island. Shortly after the station was opened, the Security Group Unit was moved from He'eia to Wahiawā (DON 2008b).

In 1941, Contractors Pacific Naval Bases (CPNAB) built housing for the Commanding Officer, junior officers, Chief Petty officers (CPO), and enlisted married men at the then named "Naval Radio Station". These quarters as well as the barracks and mess hall (Facilities 2 and 3) were designed by the well-known architect C.W. Dickey and are located in two groupings to the south of Center Street (DON 2008b).

For a short period after World War II and until 1956, the installation was used as a receiver site and the central point of communications was moved to Pearl Harbor. However, due to insufficient space and the need for expansion of facilities and consolidation of staff, the central point was relocated to the Wahiawā site in 1956. Over the years, requirements for rapid communications from the Navy to fleet operational commanders changed. As a result, by 1959, various systems, circuits, and networks were activated at NCTAMSPAC Wahiawa and the stations at Ha'ikū and He'eia were no longer needed. Additional family housing was constructed at NCTAMSPAC Wahiawa in 1965.

In 1967, the communications stations on O'ahu underwent a consolidation to become Naval Communications Station (NAVCOMSTA) Honolulu. In 1976, the name was changed to Naval Communications Area Master Station, Eastern Pacific (NCTAMS EASTPAC) and then again in 1997 to NCTAMSPAC. In 1970, the Deputy Secretary of Defense directed the Navy to study the consolidation of Army, Air Force, Navy, and Marine Corps high frequency radio

communications facilities at NCTAMSPAC. Implementation of subsequent consolidation plans have resulted in the consolidation of all Army, Navy, and Marine Corps high frequency receiver facilities, and part of the Air Force receiver facilities at NCTAMSPAC Wahiawa.

2. Camp Stover Housing Community

The 200 FHU at Camp Stover were originally built in 1973 and 110 FHU have been revitalized in recent years. The Navy acquired the land in 1949 (NAVFAC PAC 2006g).

5.1.1.6 Regional Land Uses

1. NCTAMSPAC Wahiawa

The location of NCTAMSPAC Wahiawa was carefully chosen from engineering studies as best suited to support the mission, tasks, and functions of the command. The mountainous terrain of O'ahu makes the central plateau most suitable for a high frequency radio-receiving site. The station is bordered on the north and south by deep gulches that are unsuitable for development and which serve as effective natural buffer zones. The down slope (west) side is agricultural land (tree farm and fallow pineapple fields) and upslope (east) lies the Ko'olua Mountain Range/SOH Forest Reserve; both uses are considered desirable as a buffer zone for the receiving antennas. Future industrial or urban development of the agricultural land or forest reserve would constitute an incompatible use.

NCTAMSPAC Wahiawa lands, and most of the surrounding lands in Central O'ahu, are in the State Agricultural District. The lands above the installation (Ko'olau Mountain Range and forest reserve) lie within the State Conservation District (SOH LUC 2009).

Land adjacent to NCTAMSPAC Wahiawa is largely devoted to agriculture. Whitmore Village, a plantation town (2000 population: 3,400), lies one mi (1.6 km) west of the installation. The nearest urban center is the town of Wahiawā (2000 population: 48,905), located 3 mi (4.8 km) southwest of the facility. NCTAMSPAC Wahiawa is zoned by the CCH as F-1 (Military and Federal Preservation) and is bordered by P-1 zoning (Restricted Preservation District) on its upland (eastern) boundary and AG-1 zoning (Restricted Agricultural District) to the north, west and south (CCH 2008).

2. Camp Stover Housing Community

The Camp Stover Housing Community sits within the State Urban District. It is surrounded on the north and west by Urban District lands (including Wheeler Army Airfield), and the south and east by lands within the State Agricultural District. It is within and bordered by F-1 zoning (Military and Federal Preservation) with AG-1 zoning (Restricted Agricultural District) to the south and east (CCH 2008).

5.2 GENERAL PHYSICAL ENVIRONMENT

The discussion of the general physical environment is divided into six subsections (5.2.1 through 5.2.6): (1) physical geography; (2) topography; (3) climate; (4) geology; (5) soils; and (6) hydrology – including surface water resources and hydrogeology (groundwater resources). General island-wide descriptions of these resources are presented in Section 2.2; the following discussion addresses the NCTAMSPAC INRMP Study Area and environs.

5.2.1 Physical Geography

A general discussion of the physical geography of the Hawaiian Islands and O'ahu is presented in Section 2.2.1. The NCTAMSPAC INRMP Study Area is located on an upland plateau known as the Schofield Plateau and consists of gently sloping land and steep-sided ravines. It has been deeply dissected by major streams draining from the Ko'olau Mountain Range.

The gulches bordering NCTAMSPAC Wahiawa include the north fork of Kaukonahua Stream to the south, and Poamoho Stream to the north. NCTAMSPAC Wahiawa is further divided by a small gully that separates the operations and community area on the south from the antenna fields on the north. An unnamed gulch that contributes to the Waikele Stream is located to the west of the Camp Stover housing community.

5.2.2 Topography

A general discussion of O'ahu's topography is presented in Section 2.2.2. Land occupied by NCTAMSPAC Wahiawa slopes gently east to west from an elevation of approximately 1,300 ft (396.2 m) above msl to an elevation of 1,000 ft (304.8 m) above msl (Figure 5-4). The slope of the plain averages three percent. As the foothills of the Ko'olau Range are encountered a short distance east of the station, the terrain at the station is generally suitable for development except for the steep sided Poamoho Gulch that traverses the site (DON 2001c).

Camp Stover housing community slopes gently to moderately to the south from an elevation of approximately 780 ft (238 m) above msl to an elevation of 720 ft (220 m) above msl (Figure 5-4).

5.2.3 Climate

A general discussion of the climate for the island of O'ahu is presented in Section 2.2.3. The average temperature at NCTAMSPAC Wahiawa is 70° F (20° C). The maximum has reached 90° F (32° C) but is rarely recorded. The minimum is 46° F (7.8° C). Temperatures near 50° F (10° C) are common on cold winter nights. The mean maximum is 76° F (24° C) and the mean minimum is 62° F (16.7° C) (DON 2001c). The temperature range at Camp Stover is similar to that of NCTAMSPAC Wahiawa.

Rainfall records for a number of sites in the Wahiawā region have been published, but none are located within NCTAMSPAC Wahiawa and Camp Stover. Normal tradewind weather brings substantial rainfall to the area. At least one-third of the annual total originates with orthographic showers associated with the tradewinds. Most of the remainder accompanies winter storms, and a small fraction falls as showers from convective clouds. The DLNR rainfall map (1982)

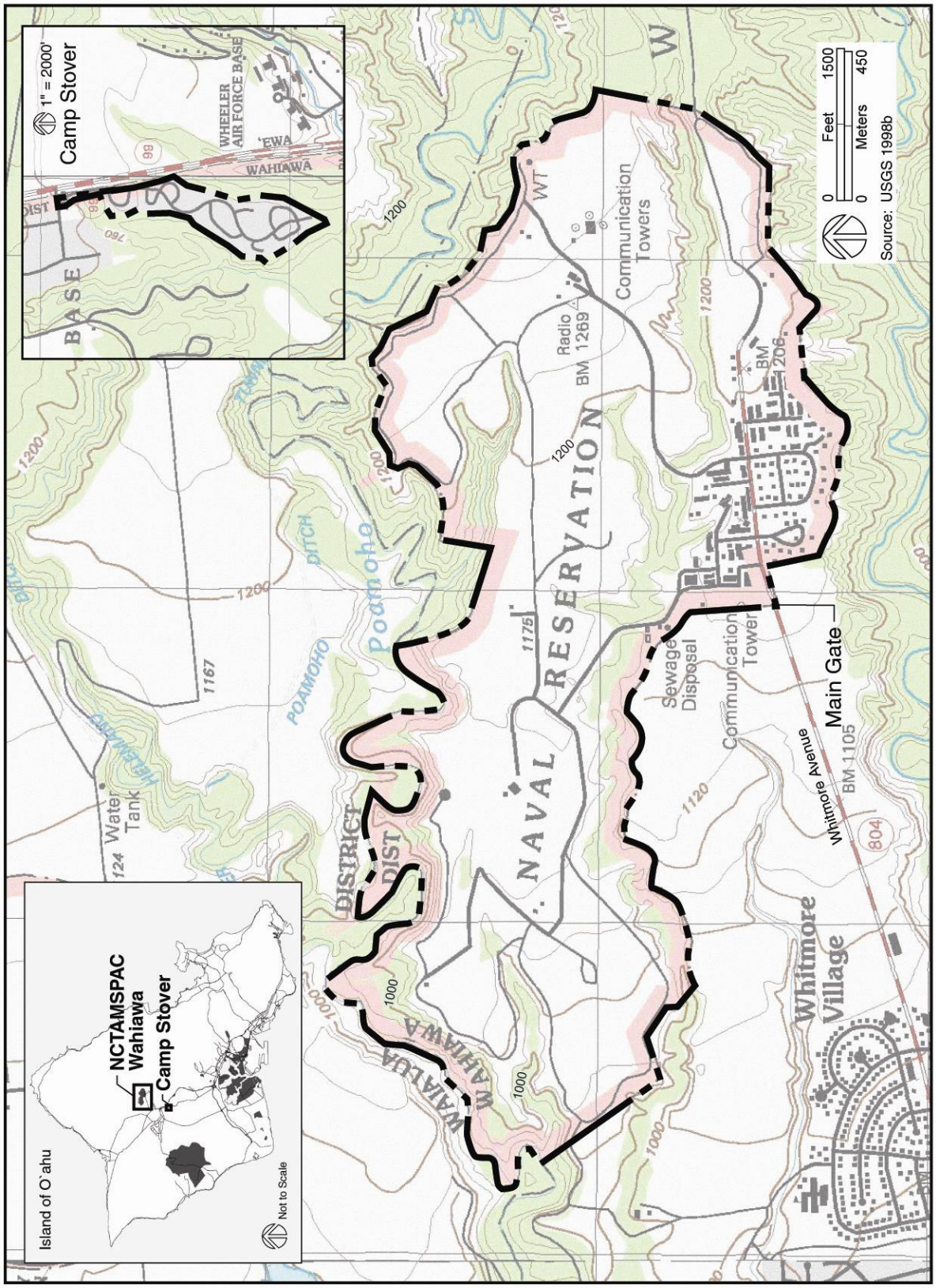

Figure 5-4: Topography, NCTAMSPAC Study Area

indicates an annual rainfall range from 65 in (165.1 cm) at the westerly boundary to 75 in (190.5 cm) at the Forest Reserve line.

5.2.4 Geology

A general discussion of the geology of O'ahu is presented in Section 2.2.4. Located adjacent to the foothills of the Ko'olau Range on the Schofield Plateau of central O'ahu, NCTAMSPAC Wahiawa is underlain by lavas from the Ko'olau Range. The rocks of the ancient Ko'olau Volcano are chiefly thin tholeiitic basalts with minor amounts of ash, and their associated dike feeders (Stearns 1985).

The Camp Stover Housing Community is also located within the Schofield Plateau and is underlain by alluvium derived from the eroded Wai'anae and Ko'olau Volcanoes.

5.2.5 Soils

1. NCTAMSPAC Wahiawa

The soils at NCTAMSPAC Wahiawa reflect the geology of the region and are generally deep, well-drained silty clays. The surface soils consist of residuum overlying 50 to 100 ft (15 to 30 m) of weathered basalt known as saprolite. Alluvium accumulation in gulches is too meager to be consequential. Soils found at the installation exhibit suitable properties for agricultural development. All of the soils at the installation support vegetative cover suitable for grazing purposes. HLMG, which is characterized as having a severe to very severe erosion hazard, is the only soil on the installation that cannot be used as cropland (USDA 1972). Figure 5-5 shows the soil types for the installation and Table 5-1 provides a description of these.

Current land practices maintain adequate vegetative cover and no major erosion problems are found at the installation. Two minor erosion problems have been identified in the Poamoho gulch: (1) the southern slope of the gulch is vulnerable to serious erosion; and (2) extensive use of dirt bikes and other all-terrain vehicles in the gulches north of the installation have severely eroded gulches on both sides of the stream (DON 2001c).

2. Camp Stover Housing Community

Camp Stover is largely underlain by Wahiawā Silty Clay, 0 to 3 Percent Slopes (WaA), with smaller portions near the gully underlain by HLMG (Figure 5-5).

5.2.6 Hydrology

A general discussion of the hydrogeology of the Hawaiian Islands and O'ahu is presented in Section 2.2.5. The discussion of hydrology for the NCTAMSPAC INRMP Study Area is divided into two sections: (1) a discussion of surface water resources and (2) a discussion of hydrogeology or groundwater resources.

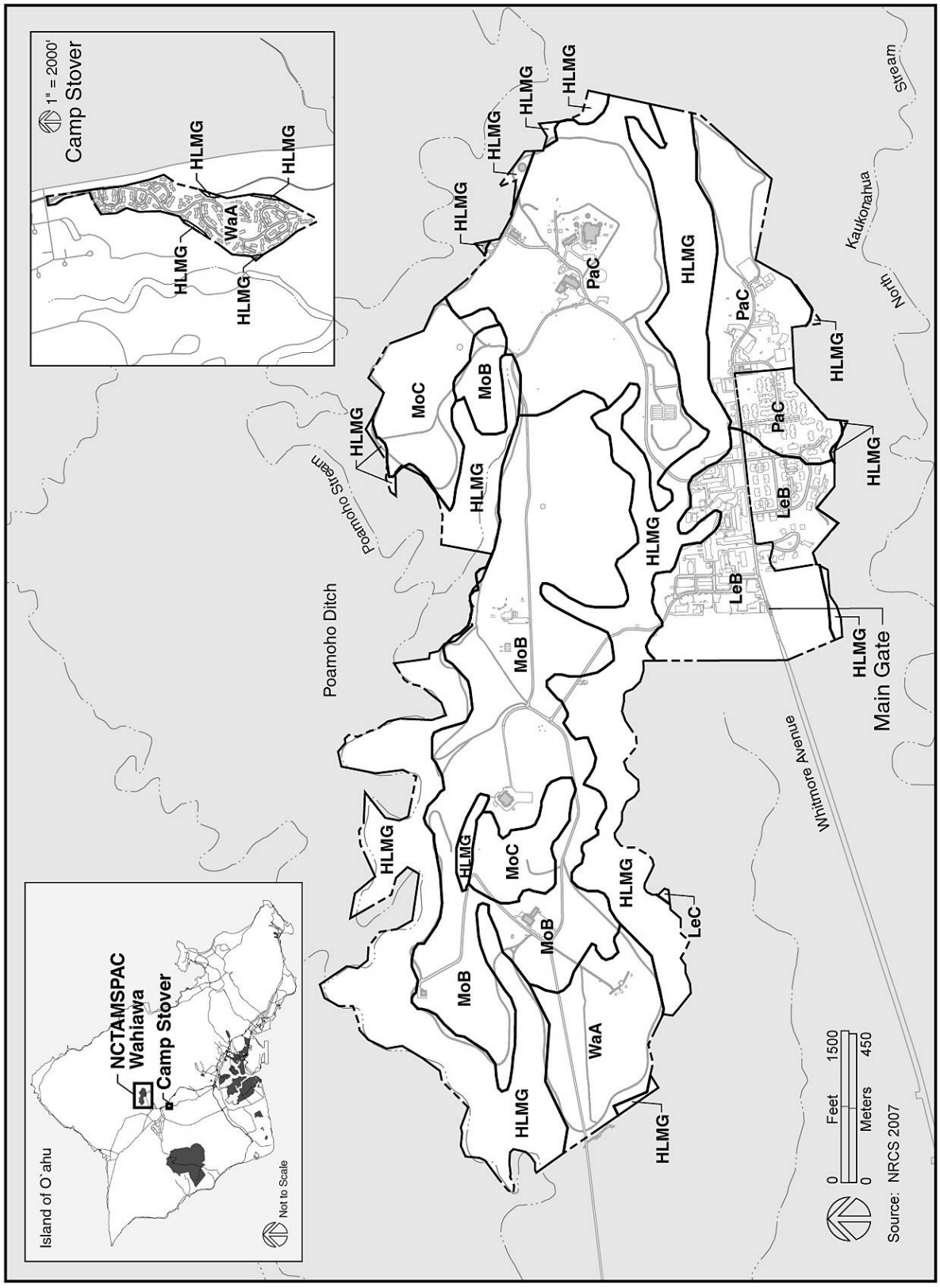

Figure 5-5: Soils, NCTAMSPAC Study Area

Table 5-1: Soils, NCTAMSPAC Study Area

Soil Type	Location	Description	Characteristics
Helemano Series: This series consists of well-drained soils on alluvial fans and colluvial slopes on the sides of gulches. They developed in alluvium and colluvium derived from basic igneous rock.			
Helemano silty clay, 30 to 90 percent slopes (HLMG)	These soils can be found on the sides of V-shaped gulches including portions of NCTAMSPAC Wahiawa and Camp Stover Housing Community.	The surface layer is neutral, dark reddish-brown silty clay (~10 in [25 cm] thick). The subsoil (~50 in [127 cm] thick) is neutral to slightly acid, dark reddish-brown and dark-red silty clay that has subangular blocky structure. The substratum is soft, highly weathered basic igneous rock.	Permeability is moderately rapid. Runoff is medium to very rapid and the erosion hazard is severe to very severe. Available water capacity was not reported.
Leilehua Series: consists of well-drained soils on uplands. Soils of this series developed in material weathered from basic igneous rock.			
Leilehua Silty Clay, 2 to 6 percent slopes (LeB)	LeB occurs as broad areas, as well as narrow areas, bordered by gulches including portions of NCTAMSPAC Wahiawa.	In a representative profile, the surface layer of LeB is dark reddish-brown silty clay about 12 in (30 cm) thick. It contains concentrations of heavy minerals. The subsoil, about 36 in (91 cm) thick, is dark reddish-brown and dusky-red silty clay and clay that has subangular blocky structure. The substratum is dark reddish-brown clay mixed with weathered gravel. The soil is extremely acid throughout the profile.	Permeability is moderately rapid, runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.3 in (3 cm) per ft (30 cm) of soil.
Leilehua Silty Clay, 6 to 12 Percent Slopes (LeC)	LeC occurs as broad areas, as well as narrow areas, bordered by gulches including portions of NCTAMSPAC Wahiawa.	This soil is similar to LeB in soil profile.	This soil is similar to LeB; however, for this soil, runoff is medium and erosion hazard is moderate. Workability is slightly difficult because of the slope.
Mānana Series: Consists of well-drained soils on uplands. Soil of this series developed in material weathered from basic igneous rock.			
Mānana silty clay loam, 6 to 12 percent slopes (MoC)	These soils occur on smooth slopes including portions of NCTAMSPAC Wahiawa.	The surface layer is strongly acidic, dark reddish-brown silty clay loam (8 in [20 cm] thick). The subsoil (about 42 in [107 cm] thick) is strongly to extremely acidic, dusky-red, dark reddish-gray, and dark reddish-brown silty clay that has subangular blocky structure. A nonporous, pan-like sheet (0.125 to 0.25 in [0.32 to 0.64 cm] thick) occurs in the subsoil from 15 to 50 in (38 to 127 cm). The substratum is strongly to extremely acidic, soft, weathered basic igneous rock.	Permeability is moderately rapid above the pan and moderate below. Runoff is medium, and the erosion hazard is moderate. The available water capacity is 1.2 in/ft (10 cm/m) in the surface layer and 1.3 in/ft (11 cm/m) in the subsoil.
Mānana Silty Clay Loam, 2 to 6 Percent Slopes (MoB)	MoB occurs on smooth slopes in the uplands including portions of NCTAMSPAC Wahiawa.	This soil is similar to MoC in soil profile.	This soil is similar to MoC; however, runoff is slow and the erosion hazard is slight.
Pa'aloa Series: Consists of well-drained soils on uplands. Soils of this series developed in old alluvium and residuum derived from basic igneous rock.			

Table 5-1: Soils, NCTAMSPAC Study Area (Continued)

Soil Type	Location	Description	Characteristics
Pa'aloa Silty Clay, 3 to 12 Percent Slopes (PaC)	PaC occurs as narrow areas bounded by steep gulches including portions of NCTAMSPAC Wahiawa.	In a representative profile of PaC, the surface layer, about 17 in (44 cm) thick, is a mixture of dark-brown and dark-reddish-brown silty clay and clay. The subsoil, about 43 in (109 cm) thick, is dark reddish-brown silty clay and clay that has subangular blocky structure. The substratum is soft, weathered rock. The soil is strongly acid to very strongly acid. The slope range is 3 to 12 percent, but in most places it is 3 to 8 percent. The slopes are smooth.	Permeability is moderately rapid, runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.2 in (3 cm) per ft (30 cm) in the surface layer and 1.4 in (4 cm) per ft (30 cm) in the subsoil.
Wahiawā Series: Consists of well-drained soils on uplands. These soils developed in residuum and old alluvium derived from basic igneous rocks.			
Wahiawā Silty Clay, 0 to 3 Percent Slopes (WaA)	WaA occurs on smooth, broad, interfluves including the majority of the Camp Stover Housing Community.	In a representative profile of WaA, the surface layer is very dusky red and dusky-red silty clay about 12 in (30 cm) thick. The subsoil, about 48 in (122 cm) thick, is dark reddish-brown silty clay that has subangular blocky structure. The underlying material is weathered basic igneous rock. The soil is medium acid in the surface layer and medium acid to neutral in the subsoil.	Permeability is moderately rapid, runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.3 in (3 cm) per ft (30 cm).

Source: USDA 1972 and NRCS 2007

5.2.6.1 Surface Water Resources

1. NCTAMSPAC Wahiawa

NCTAMSPAC Wahiawa is located on the upper reaches of a sloping plateau adjacent to the 'Ewa Forest Reserve on the leeward slope of the Ko'olau Mountain Range. Two branches of Poamoho Stream dissect the plateau and as such, the installation is located within a series of watersheds off the leeward slope of the Ko'olau Mountain Range. The streams are contained in deep, forested gulches. NCTAMS PAC Wahiawa covers part of the wide interfluve separating the deep valleys of the north fork of Kaukonahua Stream on the south and Poamoho Stream on the north. The largest gulch within the installation is a tributary of Poamoho Stream about 50 ft (15 m) deep and following an east-west course (Figure 5-4). Given the depth of the gulch and its small drainage area, flooding during heavy rainfall is unlikely. However, floodwaters could reach the low road crossings. The drop from the edge of the interfluve into Poamoho and the north fork of Kaukonahua Stream is approximately 200 ft (61 m) over an average slope of 50 percent. The Poamoho Stream system ultimately drains into the ocean at Hale'iwa approximately 9 mi (14.5 km) downstream (DON 2001c).

2. Camp Stover

An unnamed tributary of Waikele Stream is located immediately west of the Camp Stover Housing Community and Waikakalaua Stream is located approximately 0.25 mi (0.40 km) to the east and south (Figure 5-4).

5.2.6.2 Hydrogeology

Section 2.2.5 describes the four major aquifer types that occur at PHNC and other parts of O'ahu.

1. NCTAMSPAC Wahiawa

NCTAMSPAC Wahiawa is underlain by a high-level, unconfined, dike impounded aquifer of the Central Aquifer Sector, Wahiawā System (aquifer 30501212/11111). This aquifer is currently used as drinking water and is fresh. It is considered irreplaceable and has a high vulnerability to contamination (Mink and Lau 1990). A potable water production well exists at the installation.

2. Camp Stover

The Camp Stover housing community is underlain by a basal, unconfined, flank aquifer of the Waipahu Aquifer System of the Pearl Harbor Aquifer Sector (30203111 [11111]). This aquifer is irreplaceable with a high vulnerability to contamination, is currently used for drinking water, and is fresh (Mink and Lau 1990).

5.3 GENERAL BIOTIC ENVIRONMENT

Information on biological resources presented in this and subsequent sections are primarily derived from surveys of terrestrial plants and animals conducted at NCTAMSPAC Wahiawa as part of the INRMP update process and the 2001 INRMP. Although Camp Stover Housing Community has some mature trees, it has limited natural resource value; for that reason, the Navy has not conducted natural resource surveys there.

- Flora and Fauna Survey of the Naval Computer and Telecommunications Area Master Station Pacific, O'ahu, Hawai'i (HNHP 2004b; Appendix D1)
- Plants of Naval Computer and Telecommunications Area Master Station Pacific (DON 2001c; Appendix D2)
- List of Animals, Naval Computer Telecommunications Area Master Station Pacific (DON 2001c; Appendix D4)

The discussion of the general biotic environment at NCTAMSPAC Wahiawa and Camp Stover Housing Community is divided into five subsections (5.3.1 through 5.3.5): (1) threatened and endangered species and species of concern; (2) wetlands; (3) ecosystems; (4) wildlife; and (5) vegetation.

5.3.1 Threatened and Endangered Species and Species of Concern

One SOH-listed (only on O'ahu) endangered bird species, the Hawaiian short-eared owl, may be present at the NCTAMSPAC Wahiawa. The endemic Hawaiian short-eared owl may utilize the wooded gulches and open grass habitat, but none were observed during intensive field surveys at the station in 1986. The owl is very rare on O'ahu, has been listed as endangered on O'ahu by the SOH, and is further described in Section 3.3.1.1. The Hawiian hoary bat may occur at the station (Section 4.3.1.1) There are no federally- or SOH-listed plant species at NCTAMSPAC Wahiawa (HNHP 2004b). There are no critical habitats, natural resource research areas, or ecological reserves at NCTAMSPAC Wahiawa.

There are no federally- or SOH-listed threatened or endangered animal or plant species known to occur at the Camp Stover Housing Community. There are no critical habitats, natural resource research areas, or ecological reserves at the Camp Stover Housing Community.

5.3.2 Wetlands

1. NCTAMSPAC Wahiawa

There are no USACE jurisdictional wetlands at the installation. The USFWS classifies the stream gulches at NCTAMSPAC Wahiawa (Figure 5-4) as "Palustrine System, Forested Class, Broad-leaved Evergreen Subclass, Non-tidal Temporary" (DON 2001c).

2. Camp Stover Housing Community

There are no surface water bodies at the Camp Stover Housing Community. An unnamed tributary to Waikele Stream is located immediately west of the community and Waikakalaua Stream is located approximately 0.25 mi (0.4 km) east and south of the community (Figure 5-4).

5.3.3 Ecosystems

The native terrestrial ecosystems of NCTAMSPAC Wahiawa and the Camp Stover Housing Community are classified as lowland dry and mesic forest, woodland, and shrubland (Juvik and Juvik 1998).

5.3.4 Fish and Wildlife

5.3.4.1 Terrestrial Animals

No natural resources surveys have been conducted for the Camp Stover Housing Community. The following discussion of animals is limited to NCTAMSPAC Wahiawa and is divided into three subsections: (1) bird species; (2) mammal species; and (3) amphibian and reptile species.

1. Bird Species

As discussed in Section 5.3.1.1, the SOH-listed (on O'ahu only) endangered, Hawaiian short-eared owl may occur at NCTAMSPAC Wahiawa. One MBTA-protected bird species, the Pacific golden plover, is a seasonal visitor to NCTAMSPAC Wahiawa. The Pacific golden plover is the second most abundant bird species occurring at NCTAMSPAC Wahiawa and is normally found on mown grasslands (DON 2001c). Table 3-11 (Section 3.3.4.1) provides a description of this bird species.

There are two endemic bird species that may utilize habitat in gulches: (1) O'ahu 'amakihi (*Hemignathus virens chloris*); and (2) *'*apapane (*Himatione sanguinea*) (Hawaiian Agronomics 1986 in DON 2001c). Twenty-two introduced or alien bird species have been recorded at the installation (Appendix D5). Approximately one half of the alien birds regularly utilize the grassland habitat and two-thirds of the bird species can be found in numerous fingers of forested gullies adjacent to the mowed areas. Without the protective cover of these gulches, birds would be much lower in number and less varied.

2. Mammal Species

The only mammals observed at NCTAMSPAC Wahiawa are alien species. They include mongoose, feral cats, feral dogs, feral pigs, and several species of introduced rodents (HNHP 2004b and Hawaii Agronomics 1986 in DON 2001c).

3. Amphibian and Reptile Species

An amphibian and reptile species survey was not conducted for NCTAMSPAC Wahiawa or the Camp Stover Housing Community; the Navy focused amphibian and reptile species (herpetological) surveys on areas containing native plant and animal species, such as Lualualei, where they may have a more serious negative ecological impact.

5.3.4.2 Marine Animals

NCTAMSPAC Wahiawa and the Camp Stover Housing Community are upland sites not directly adjacent to or affecting the marine environment. Therefore, a discussion of marine fauna is not warranted.

5.3.5 Vegetation

No botanical surveys have been conducted for the Camp Stover Housing Community. The following discussion is limited to NCTAMSPAC Wahiawa.

A total of 95 plant species were found at NCTAMSPAC Wahiawa (Hawaiian Agronomics 1986 in DON 2001c). Only five plant species are endemic (occurring naturally only in the Hawaiian Islands), eight are indigenous (occurring naturally in the Hawaiian Islands and elsewhere), one is of Polynesian introduction (prior to European contact), and the remainder are alien species that were introduced intentionally or accidentally after European contact. Pockets of native mesic forest occur in Poamoho Gulch at the northern boundary of the installation (Figure 5-2). The following paragraphs provide a description of the vegetation associated with: (1) the developed portions of the installation; and (2) Poamoha Gulch and Kaukonahua Gulch.

5.3.5.1 Developed Portions of the Installation

The character-defining vegetation associated with NCTAMSPAC Wahiawa is the expansive carpet of grasses and lack of vertical vegetation in the antenna fields, and the dense, natural vegetation within the gulches (Figure 5-6). In the community support area, character-defining vegetation includes groves of trees associated with the historic housing neighborhood and historic streetscape plantings. Informal, yet visually prominent, plantings of Norfolk Island pine trees are scattered throughout the community area (DON 2001c).

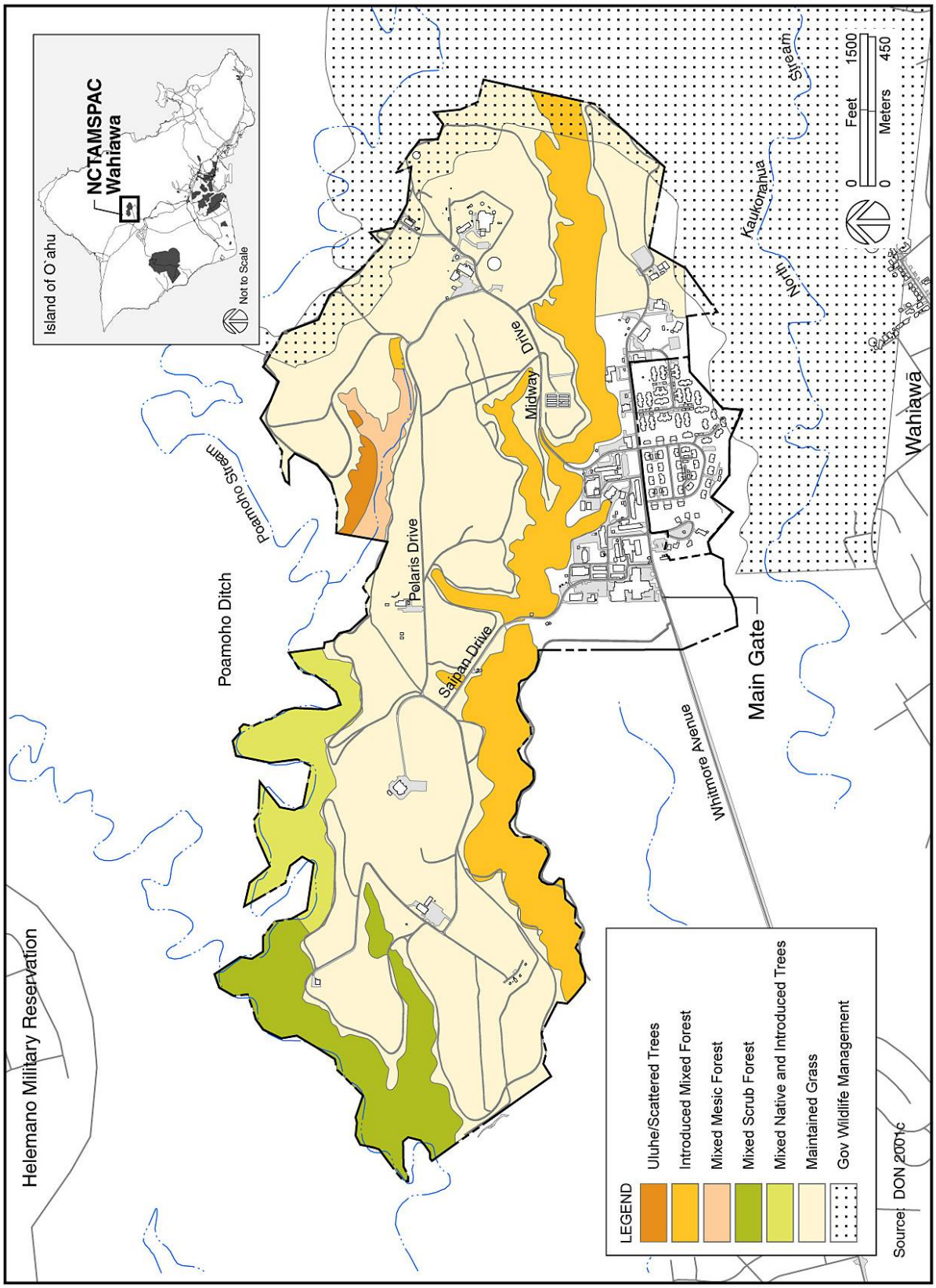

Figure 5-6: Vegetation, NCTAMSPAC Wahiawa

The housing area borders a natural forest area and gulch, creating a natural boundary to the south with dense mature trees. Within the housing community, the homes are set back far enough from the street to provide for landscaped front yards, which blend to form a central open space. The large front and back yards are typically open and informal with personalized foundation plantings, commonly hibiscus, dracaena, panax, croton, and ti. Large banyan, monkeypod, African tulip, eucalyptus, blue marble tree, silk oak, Norfolk Island pine, and coconut palm trees line the streets and are scattered around the homes providing shade and creating a park-like setting for this neighborhood (DON 2008b).

Aside from the administrative complex at NCTAMSPAC Wahiawa, mowed fields composed primarily of several grass and herbaceous species dominates the greater part of the 694 ac (280.5 ha) site (Figure 5-6). A narrow band of vegetation along the perimeter of the lawn consists of a mixture of taller grass species and an assortment of shrubs and trees. The area occupied by the maintained lawn is composed almost exclusively of alien species.

5.3.5.2 Poamoha Gulch and North Kaukohaua Gulch

No rare or protected plant species were found in the forested gulches, which include: (1) a large branch of Poamoho Gulch at the northern boundary; (2) a smaller branch of Poamoho Gulch on the southwest boundary; (3) a smaller branch of Poamoho Gulch which bisects the southern eastern portion of the installation; and (4) the North Kaukohaua Gulch at the southeastern boundary of the facility (HNHP 2004b). In some portions of the Poamoho Gulch the vegetation is still native dominated. In other portions of the gulches the vegetation is now dominated by alien plants, but still contains native remnants (Figure 5-6). Ungulate damage was observed in the southern gulch that bisects the southern eastern portion of the installation. Erosion damage associated with dirt bikes was observed in Poamoha Gulch at the northern boundary of the installation (DON 2001c).

A pocket of native forest trees is found in a small gulch of the larger Poamoho Gulch system. It includes abundant ʻōhiʻa trees and scattered trees of koa, sandalwood (*Santalum freycintetianum*), ʻōhiʻa hā (*Syszgium sandwicensis*), halapepe, olpua (*Nestegis sandwicensis*), and ʻahakea (*Bobea brevipes*). On the slopes where the canopy cover is more open, uluhe or false staghorn fern (*Dicranopteris learis*) forms a thick mat in between trees. Where the uluhe fern is not dense, an assortment of shrub, herb, and fern species may be found. These include ʻākia (*Wikstroemia oahuensis*), pūkiawe (*Styphelia tameiameiae*), naupaka kuahiwi (*Scaevola guadichaudiana*), pamakani-makhu (*Phyllanthus sandwicensis*), ʻukiʻuki (*Dianella sandwicensis*) and various members of the sedge family (*Gahnia globosa* [NCN], *Carex meyenii* [NCN], and *Carex wahuensis* [NCN]). Among the ferns observed were ʻōkupukupu (*Doodia kunthiana*), palaʻā (*Sphenomeris chinensis*), and waiwaiʻiole (*Lycopodium cernuum*), a fern ally. Occasionally, ʻieʻie (*Freyecinetia arborea*) can be seen climbing up tree trunks (DON 2001c).

The 2001 INRMP for NCTAMSPAC noted the presence of strawberry guava (*Psidium cattleianum*), common guava (*Psidium guajava*), and liliko'i (*Passiflora edulis*) found in the scrubby perimeter vegetation. These fruits are sometimes collected during the summer and eaten fresh or made into jams and jellies (DON 2001c).

5.4 CURRENT MANAGEMENT

5.4.1 Protected-Species and Ecosystem Monitoring and Management

5.4.1.1 Protected Species Monitoring and Management

There are no ESA-protected species, critical habitat, or species of concern at the NCTAMSPAC INRMP Study Area except for the potential presence of the SOH-listed, endangered (on O'ahu) short-eared owl (Section 5.3.1.1). There is one MBTA-protected bird species (Pacific golden plover) that does occur at NCTAMSPAC Wahiawa.

1. Hawaiian Short-eared Owl

There are no current management actions for the Hawaiian short-eared owl (Section 5.3.1.1) which may be present at NCTAMSPAC Wahiawa.

2. Pacific Golden Plover

There are no current management actions for the Pacific golden plover (Section 5.3.4.1) which are present at NCTAMSPAC Wahiawa.

5.4.1.2 Access Restrictions

Access to NCTAMSPAC Wahiawa and the Camp Stover Housing Community is restricted to authorized personnel, residents, and guests. These restrictions provide a *de facto* preserve to the pocket of native mixed mesic forest trees at NCTAMSPAC Wahiawa.

5.4.1.3 Invasive Species Prevention and Control

The Navy currently supports a feral pig hunting program at NCTAMSPAC Wahiawa in an effort to reduce the numbers of these animals there (Appendix I9). Feral pigs are an invasive species. They are a safety concern for residents and personnel on NCTAMSPAC Wahiawa and contribute to the destruction of native plants and soil erosion/stability problems.

5.4.1.4 Natural Resource Restoration

There are no current natural resource restoration projects at NCTAMSPAC Wahiawa or the Camp Stover Housing Community.

5.4.1.5 Wetlands

Wetlands at NCTAMSPAC Wahiawa are limited to the stream gulches (Section 5.3.2); there are no surface water bodies at the Camp Stover Housing Community. The Navy has a no-net-loss of wetlands policy and has continued to protect the stream gulches from development. The Navy provides for formal wetland training for CNRH, NAVFAC HI, and NAVFAC PAC natural resources and environmental staff.

5.4.2 Natural Resources Studies

The Navy updated flora and fauna surveys for NCTAMSPAC Wahiawa in 2004 (HNHP 2004b, Appendix D1).

5.4.3 Use of Geographic Information Systems

NAVFAC PAC Natural Resources staff are continually updating their GIS database to include the locations of native and/or protected animal and plant species.

5.4.4 Forestry

There is no existing forestry management program for NCTAMSPAC Wahiawa or the Camp Stover Housing Community. There is a pocket of native mixed mesic forest trees in a small side gulch of the larger Poamoho gulch system at NCTAMSPAC Wahiawa. Trees observed in this area include 'ohi'a hā, koa, sandalwood, halapepe, olopua, and 'ahakea. The remnant pocket of native mesic mixed forest provides a good control for soil erosion and runoff as well as reduces siltation of the streams located on the gulch bottoms. In addition, the vegetated areas improve groundwater supplies and provide food and shelter for wildlife. Accelerated soil erosion is a primary concern on the precipitous gulch slopes and the rugged terrain of these areas would preclude harvesting of timber resources even if a market for wood products from the facility could be found. The Navy continues to protect native forests and mature and significant trees at NCTAMSPAC Wahiawa and the Camp Stover Housing Community.

5.4.5 Community Outreach

There are no current community outreach natural resources management actions at NCTAMSPAC Wahiawa or the Camp Stover Housing Community.

5.4.6 Outdoor Recreation

Operational constraints (primarily EMR and security requirements) at NCTAMSPAC Wahiawa limit the availability of land suitable for development of outdoor recreation activities. In addition, the small number of on-base residents makes it difficult to justify additional recreational facilities. Although no formal recreational hiking/walking activities take place on NCTAMSPAC Wahiawa, there are rough trails present throughout the Poamoho Gulch system and perimeter. Access to the Poamoho Valley trail is located off the southeastern point of the installation.

Outdoor recreation at the Camp Stover Housing Community is limited to passive nature walks and bicycling.

5.4.7 Land Management

Ongoing land management programs at NCTAMSPAC Wahiawa and the Camp Stover Housing Community are similar to those discussed in Section 3.4.7. They include base planning, reduction of point source pollution, utilization of BMPs during earthwork and construction and storm drain design, non-point source pollution prevention for JBPHH. In addition, the Navy provides grass and vegetation management within the antenna fields and required buffer zones at NCTAMSPAC Wahiawa and landscape management at the Camp Stover Housing Community. Also, the Navy manages, maintains, and promotes soil stability and erosion control

for land areas with natural resources value (primarily within Poamoho Gulch) and other areas prone to soil erosion at NCTAMSPAC Wahiawa and the Camp Stover Housing Community.

5.4.8 Floodplains

Flooding is not a problem at NCTAMSPAC Wahiawa. The largest gulch within its boundaries is about 50 ft (15 m) deep and covered with vegetation at channel level. Periods of stream flow are infrequent. South and upstream of the installation, the drainage area of the gulch is relatively small, only 60 ac (24 ha); another 445 ac (178 ha) are added in its course through the sub-installation. The depth of the gulch and its small drainage area generally prevents overflow.

Similar to NCTAMSPAC Wahiawa, flooding is not a problem at the Camp Stover Housing Community which is located upgradient from a tributary to the Waikele Stream and the Waikakalaua Stream.

5.4.9 Law Enforcement

NCTAMSPAC Wahiawa is policed by the Navy base police. Law enforcement at the Camp Stover Housing Community is provided by the HPD and private security firms.

5.4.10 Wildland Fire

Wildland fires have not impacted NCTAMSPAC Wahiawa and the Camp Stover Housing Community in recent years; however, during dry conditions, wildland fires can impact the ridge line. The FFD would respond to any fires at the NCTAMSPAC Wahiawa and the Camp Stover Housing Community.

5.4.11 Leases and Encroachment Management

The lands at NCTAMSPAC Wahiawa are suitable for pineapple cultivation, diversified agriculture, and cattle grazing. Currently there are no agricultural outleases at the installation and none are planned. The lands most suitable for agricultural outlease are located on the west end of the installation, below Saipan Drive. The 2001 INRMP noted that any expenses associated with improvements required for the agricultural outlease would depend on the type of agriculture and would be borne by the lessee. In 2001, the estimated costs for improvements for pineapple cultivation would be approximately $25,000; approximately $2,000 for diversified agriculture; and approximately $25,000 for cattle grazing. Lease rent would vary from $10 per acre for cattle grazing to $100 per acre for pineapple cultivation and up to $500 per acre for diversified agriculture (e.g., coffee) (DON 2001c).

Due to the dense residential land use, there are no lands at the Camp Stover Housing Community suitable for agricultural outlease.

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CHAPTER 6
KALAELOA

CHAPTER SIX: KALAELOA

6.1 CURRENT CONDITIONS AND USE

6.1.1 Installation Information

6.1.1.1 General Information

Photo 6-1: Nimitz Beach

Kalaeloa is the name given to the former NASBP, on the southern ‘Ewa Coastal Plain of the island of O‘ahu, Hawai‘i. With the exception of family housing and support facilities, NASBP was closed on 2 July 1999 after having served for over five decades as an important naval air station and technical training school on O‘ahu. Of the original 3,679 ac (1489 ha) that comprised the former NASBP, the Navy initially retained 1,166 ac (472 ha) which has subsequently been reduced to 428 ac (173 ha) consisting of five parcels: (1) DRMO (31 ac [12.5 ha]); (2) NAVFAC HI West Oahu Shop (11 ac [4.5 ha]); (3) Biosolids Treatment Facility (74 ac [30 ha]); (4) Barbers Point Golf Course and Stables (276 ac [112.5 ha]); (5) Nimitz Beach and Cottages (Photo 6-1) (21 ac [8.5 ha]); and (6) White Plains Beach and Cottages (15 ac [6 ha]) (Figure 6-1).

In addition, there are approximately 388 ac (157 ha) comprised of six lots that the Navy is in the process of transferring ownership to other entities. These lots are identified as follows: (1) Lot 13058-B (58-B/“Triangle”); (2) Lot 13058-F (58-F/”Ordy Pond”); (3) Lot 13073-A (73-A/”Airport Wetland”); (4) Lot 13058-D (58-D/ “former Northern Trap and Skeet Range” [NTSR]); (5) Lot 13058-G (58-G/ “former Southern Trap and Skeet Range” [STSR]); and (6) Lot 13074-D (74-D/”Beach Area”) (Figure 6-1).

6.1.1.2 Land Use Constraints

No military land use constraints were identified for the Navy-retained lands at Kalaeloa. The DRMO and West Oahu Shops are highly developed and have limited natural resources value. However, the federally-listed endangered Hawaiian black-necked stilt has been reported at the Biosolids Treatment Facility, the Barbers Point Golf Course and Stables, Lot 58-F, and Lot 73-A (Figure 6-2). Three MBTA-protected birds (cattle egret, black-crowned night heron, and Pacific golden plover) occur at the Biosolids Treatment Facility, two (black-crowned night heron and the Pacific golden plover) at the Barbers Point Golf Course and Stables, and three (black-crowned night heron, Pacific golden plover, and wandering tattler) at Nimitz Beach and Cottages/White Plains Beach and Cottages.

The natural areas of the Barbers Point Golf Course and Stables is similar to the habitat for a federally-listed endangered plant species ‘Ewa Plain ‘akoko shrub (*Chamaesyce skottsbergii* var. *kalaeloana*)

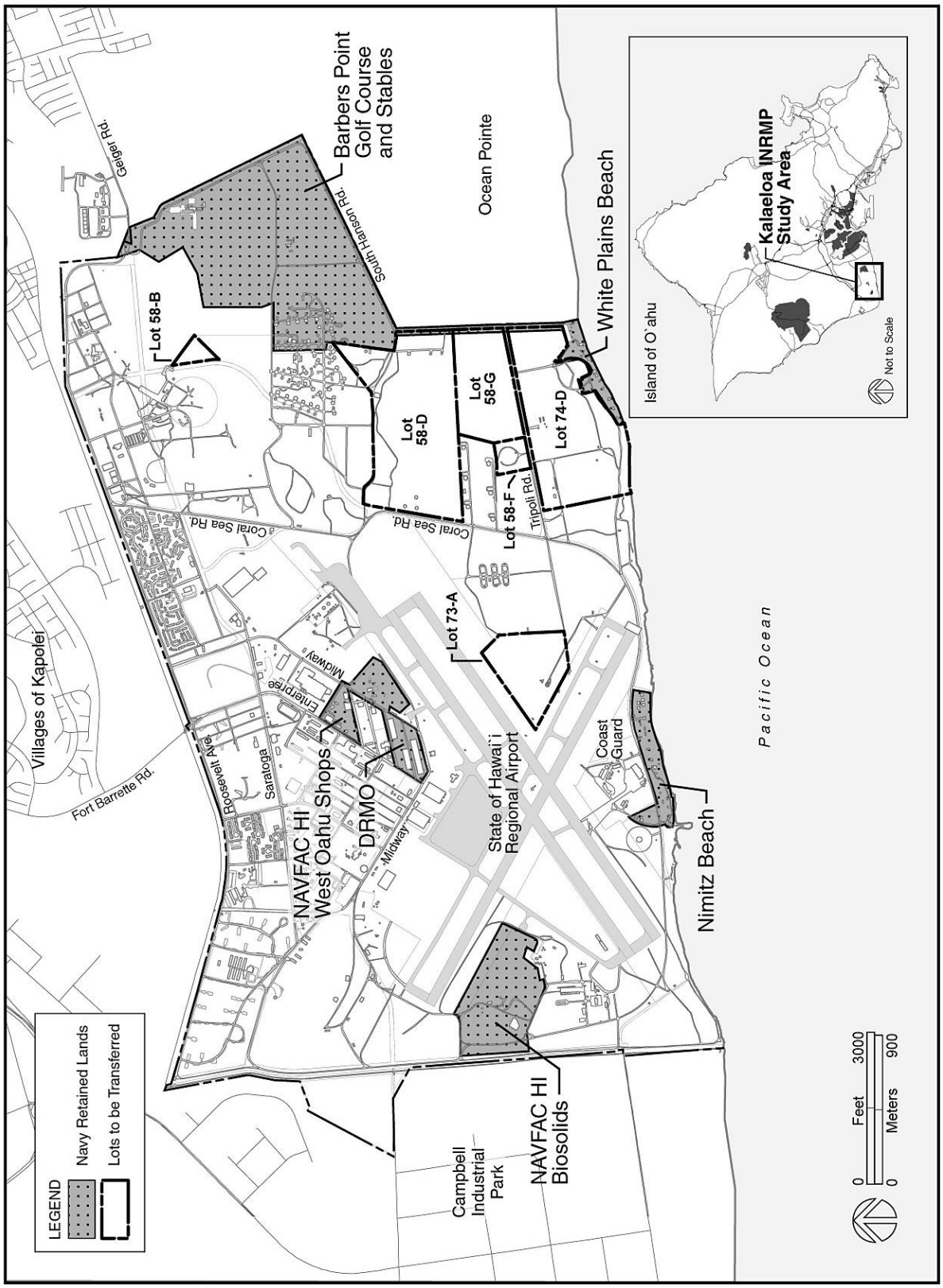


Figure 6-1: Kalaeloa Study Area

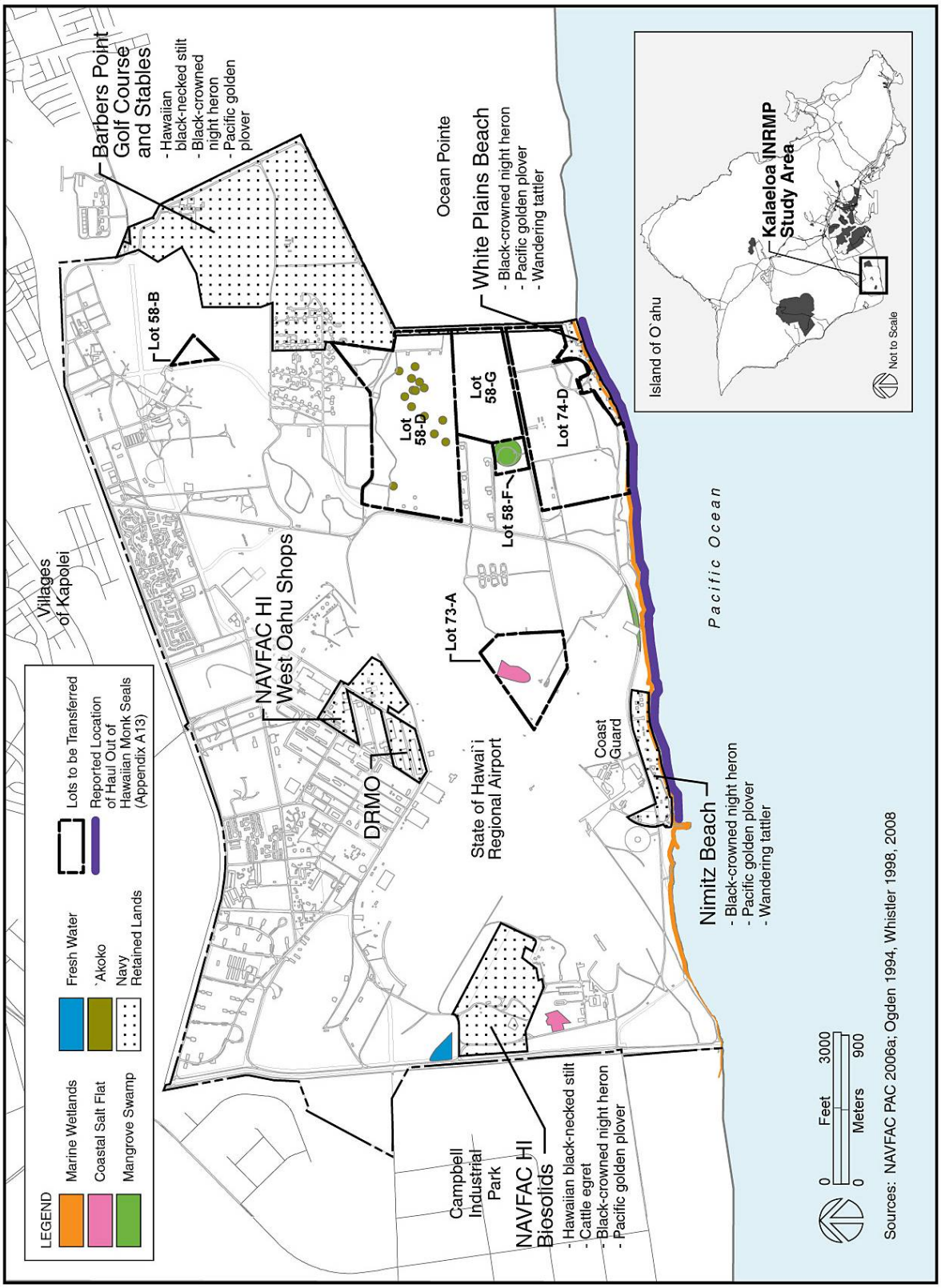


Figure 6-2: Constraints, Kalaeloa Study Area

located on Lot 58-D (NTSR) (Figure 6-2). Nimitz Beach and Cottages and White Plains Beach and Cottages are located immediately adjacent to the Pacific Ocean, contain wetlands, and are used as outdoor recreation areas by MWR-authorized patrons as well as the general public. The sedge kaluhā, which is rare on O'ahu, is located at a salt marsh within the White Plains Beach and Cottages camping area.

6.1.1.3 Land Use Opportunities

No new military mission training land use opportunities were identified at the Navy-retained lands at Kalaeloa.

6.1.1.4 Operations and Activities

As described in Section 6.1.1.1, the Navy-retained land at Kalaeloa includes six noncontiguous areas, intended for long-term retention; and six lots to be transferred; these lands are described below and their locations are shown on Figure 6-1.

1. DRMO

DRMO is located in the central portion of the former NASBP (Kalaeloa). It is largely developed with limited natural resource value.

2. NAVFAC HI West Oahu Shops

Located in the central portion of Kalaeloa, the West Oahu Shops is managed by NAVFAC HI. It is largely developed with limited natural resource value.

3. Biosolids Treatment Facility

The Biosolids Treatment Facility is located on the west end of the runway at Kalaeloa. Managed by NAVFAC HI, the treatment facility combines two waste streams (biosolids and green waste) into environmentally friendly compost used on military property. The facility is largely developed with limited natural resource value.

4. Barbers Point Golf Course and Stables

Barbers Point Golf Course and Stables lies on filled land. The stables were built in the 1950s using the existing World War II-era bombproof revetments. The stable area was incorporated as the Barbers Point Riding Club in 1993. Members may rent stables and practice horsemanship. It is the home of the equestrian competition portion of the Aloha State Games. The Barbers Point Golf Course was constructed in 1966 and is an active military golf course.

5. Nimitz Beach and Cottages

Nimitz Beach and Cottages is managed by MWR. The beach is open to MWR-authorized patrons as well as the general public; however, the cottages are available for rental by MWR-authorized patrons only.

6. White Plains Beach and Cottages

White Plains Beach and Cottages is managed by MWR. The beach is open to MWR-authorized patrons as well as the general public; however, the cottages are available for rental by MWR-authorized patrons only.

7. Lot 58-B (Triangle)

Lot 58-B (Triangle) is unused and does not contain any structures. It is located near the northeastern portion of Kalaeloa within the former Marine Corps Air Station (MCAS) runway (DON 2011a). It is bounded on the north, south, and east by the former MCAS runway and on the west by the Federal Aviation Administration beacon facility (Navy 2011).

8. Lot 58-D (NTSR)

Lot 58-D contains an area that was formerly used as a trap and skeet range. The lot is mainly open space but does contain seven structures associated with the range including: (1) Buildings 171, 172 and 173, Fuse-Detonator Magazines constructed in 1943; (2) Building 1493, Disaster Control Storage constructed in 1944; (3) Building 1527, Miscellaneous Storage constructed in 1944; (4) Building 1528, Fuse-Detonator Magazine constructed in 1944; and (5) Building 1529, believed to be an Ammunition Magazine constructed in 1944. The lot is bounded on the north by San Jacinto Road, open land, and Coral Pit No.3; on the south by the Southern Trap and Skeet Range; on the east by Essex Road and the Barbers Point Golf Course; and Ocean Pointe on the west (DON 2011a).

9. Lot 58-F (Ordy Pond)

Lot 58-F (Ordy Pond) is a nearly-rectangular lot that is located in the eastern portion of Kalaeloa. It is bounded on the north and west by Department of Hawaiian Home Lands (DHHL) land, on the east by Lot 58-G (STSR), and on the south by Tripoli Road and Lot 74-D (Beach Area). A small limestone sinkhole pond (Ordy Pond) and perimeter mangrove stand are located on the property (DON 2011a).

10. Lot 58-G (STSR)

Lot 58-G (STSR) is a nearly-rectangular lot that contains an area of approximately 46 acres (18.4 ha) that was formerly used as a trap and skeet range. The lot is located near the eastern portion of Kalaeloa, south of Lot 58-D (NTSR) and north of Tripoli Road. It is bounded on the east by Essex Road and on the west by Lot 58-F (Ordy Pond) and DHHL land. No buildings or utilities are located on the property (DON 2011a).

11. Lot 73-A (Airport Wetland)

Lot 73-A (Airport Wetland) is located adjacent to the Kalaeloa Airport runways, and was used as a buffer to the airfield and for off-site stormwater drainage purposes. Additionally, Lot 73-A is part of the airfield and is enclosed on the southern, eastern, and northern boundaries with a fence. The lot consists predominantly of vacant land covered with native vegetation. There are three structures on the parcel including: (1) Building 1667, Generator Building, constructed in 1961; (2) Building 1668, VHF/UHF Building, constructed in 1961; and (3) Building 1900, Tacan Facility, constructed in 1985. A large coastal salt flat, approximately 2 acres (0.80 hectares), is located within the parcel. A portion, less than 1 acre (0.40 hectares), contains a seasonal wetland (DON 2011a).

12. Lot 74-D (Beach Area)

Lot 74-D (Beach Area) is bound by White Plains Beach and the Pacific Ocean on the south, Essex Road and the Ocean Pointe development on the east, Tripoli Road on the north, and Coral Sea Road on the west. There is a bathhouse located on the eastern end of the beach area and there are several concrete revetments located along the beach (DON 2011a).

6.1.1.5 Abbreviated History and Pre-Military Land Use

Kalaeloa, which means long-point in Hawaiian, and the larger 'Ewa Plain lay within the ahupua'a of Honouliuli, which extends from the Wai'anae mountains, across the interior plateau, all the way to Pearl Harbor (DON 2008b). According to Native Hawaiian traditions, life was difficult in the Kalaeloa region due to the general scarcity of potable water. Archaeological research indicates that limited short-term inland agriculture probably began between 1000 and 1400 A.D., with the first settlement of the 'Ewa Plain probably beginning between about 1250 to 1450 A.D. Small fishing villages were present along the coast at the time of European contact in the late 1700s.

Kalaeloa was named "Point Banks" in 1786 by Captain Nathaniel Portlock in honor of Joseph Banks, the naturalist on Cook's first voyage into the Pacific, who was by that time president of the Royal Society of London. Point Banks was renamed "Barbers Point" when English sea captain Henry Barber lost his ship, *Arthur*, on the reef along the coast on 31 October 1796 (NAVFAC PAC 1994).

Changes in land tenure and use for Kalaeloa are documented from the 1840s. Most of these changes occurred during the Great Māhele. Kamehameha III divided the lands of the Hawaiian Kingdom into three: (1) King's Lands; (2) Chief's and Konohiki Lands; and (3) Government Lands. Honouliuli was awarded to M.W. Kekauōnohi, granddaughter of Kamehameha I, and included an area of 43,250 ac (17,503 ha) (Land Commission Award 11216). Commoners who had not participated in the Māhele were later permitted to send in their claims for a house lot and garden. The Kuleana Act of 1850 organized commoners' land claims. Ninety-seven kuleana awards were made by the Board of Commissioners to Land Titles within the ahupua'a of Honouliuli. The total land area of these 97 awards was 106.52 ac (43.1 ha), averaging a little more than 1 ac (0.4 ha) per award. Most of the awards were in the wetland taro gardens near the inland extent of West Loch of Pearl Harbor, not in the dry plain area (NAVFAC PAC 1994).

Kekauōnohi sold Pu'uloa in 1849 to Isaac Montgomery who, with King Kamehameha III, established a productive saltworks. The product of these saltworks were used by local meat packers to export their products. Upon Kekauōnohi's death in 1851, her widower, Levi Ha'alelea, inherited the remaining land. After his death in 1864, his second wife Anadelia Amoe transferred landownership to John Coney. In 1871, the property was leased to James Dowsett and John Meek to graze livestock. In 1877, Coney sold Honouliuli to James Campbell who established a cattle ranch and leased land to Chinese tenants who grew rice. Leases were also given for fishing and kiawe charcoal-making rights. In 1889, Campbell leased the Honouliuli land to Benjamin Dillingham who subleased the lower portion of the ahupua'a to the 'Ewa Sugar Plantation in 1890. Also, in 1889, Dillingham's OR&L began constructing a railroad in Honouliuli. In 1894, sisal (*Agave sisalana*) was planted for cordage southeast of Pu'u Kapolei, which led to the organization of the Hawaiian Fiber Company in 1889. The plantation operated until circa 1930 when poor market conditions forced closure. Part of Kalaeloa is located on the old sisal plantation (NAVFAC PAC 1994).

In March of 1925, the U.S. executed a lease with the OR&L to sublet 206 ac (83.4 ha) from the Campbell Estate. The originally planned military use of the area was as a dirigible mooring facility. Actual lease terms were negotiated between these three parties throughout the 1920s and 1930s. A Navy contractor cleared and built a mooring mast, and associated facilities were built by the summer of 1925. Up until 1931, the site was used only as an emergency station and was not used as a dirigible mooring until that time. The Ewa Mooring Mast Field facilities consisted of two runways, two steel hangars, 12 wooden buildings, a number of tents, and a

mooring mast. In the 1930s, a 1,500-ft (457-m) long airfield was constructed near the mooring mast (DON 2008b).

In September 1940, the Navy acquired over 3,000 additional ac (1,214 ha) to enlarge the 1,500-ft (457-m) airfield. It was usable by early 1941 and was commissioned as the MCAS Ewa in September 1942. Construction for a new Navy airfield southwest of MCAS Ewa began in November 1941 and became known as NASBP.

On 7 December 1941, the Japanese bombed the nearly completed MCAS Ewa and destroyed numerous aircraft. The construction of NASBP took place between November 1941 and July 1943. During World War II, the air station became an important air center, technical training school, and fortification manned by 12,000 sailors (DON 2008b).

After World War II ended in 1945, NASBP became a rapid demobilization center, transitioning over 6,000 personnel en route to leaving the military. MCAS Ewa and NASBP coexisted as separate air stations at the installation until Hawai'i's naval facilities were consolidated in 1949. At this time MCAS Ewa was deactivated and marine operations were moved to Kāne'ohe. NASBP absorbed MCAS Ewa and began supporting all aviation operations on leeward O'ahu. NASBP was a critical staging area for supplies, equipment, and forward-deploying squadrons during the Korean War (1950-1953). NASBP activity increased during the Cold War and became famous for its Rainbow Fleet – the P-3 patrol squadrons used to track submarines that were deployed to the northern and western Pacific, Indian Ocean, and Arabian Gulf (DON 2008b).

In 1999 NASBP was closed as a result of the 1993 Defense Base Realignment and Closure (BRAC) process. The Navy retained lands for military housing, MWR, and DRMO; however, the former base housing as well as other land initially retained by the Navy were conveyed to a master developer under the Ford Island Development Legislation in 1999 and other SOH agencies. BRAC disposed lands were acquired by various SOH and CCH agencies including the Hawaii Air National Guard (HIANG), State Department of Transportation (DOT), Department of Hawaiian Homelands (DHHL), and the University of Hawai'i. The airfield is now referred to as both the John Rogers Field and Kalaeloa Airport, and is one of the State's regional airports (DON 2008b).

Today, only 430 ac (174 ha) remain under Navy control on six noncontiguous parcels and an additional 388 ac (157 ha) are intended to be transferred from Navy control (Figure 6-1). The remainder of the former base is a patchwork of parcels with different ownership. USCG, which was a tenant of NASBP since 1949, has remained at the former installation.

6.1.1.6 Regional Land Uses

The lands comprising the former NASBP, including the Navy retained lands, are within the State Urban District. The retained lands are zoned F-1 (Federal and Military Preservation District).

6.2 GENERAL PHYSICAL ENVIRONMENT

The discussion of the general physical environment is divided into six subsections (6.2.1 through 6.2.6): (1) physical geography; (2) topography; (3) climate; (4) geology; (5) soils; and (6) hydrology – including surface water resources and hydrogeology (groundwater resources). General island-wide descriptions of these resources are presented in Section 2.2; the following discussion addresses Kalaeloa and its environs.

6.2.1 Physical Geography

A general discussion of the physical geography of the Hawaiian Islands and O'ahu is presented in Section 2.2.1. The Kalaeloa District is situated on the 'Ewa Plain, the southern coastal plain of O'ahu.

6.2.2 Topography

The ground surface at Kalaeloa slopes gently southward, from a maximum elevation of approximately 65 ft (20 m) above msl along the northern border, to sea level at the southern coastal boundary (Figure 6-3) (NAVFAC PAC 1994).

6.2.3 Climate

See Section 2.2.3 for a discussion of island-wide climatic conditions. The trade winds are less pronounced on the leeward southern coastal plain of O'ahu, but at Kalaeloa, local land and sea breezes prevail most of the year. Temperatures in the region are pleasant throughout the year. The mean annual temperature is 76° F (24° C), varying from a mean of 72° F (22° C) in winter to 79° F (26° C) during the summer. Summertime temperatures rarely exceed 90° F (32° C). The temperature may dip into the low 50s F (10s C) on a few occasions during the winter each year following a cold frontal passage. Rainfall in the Kalaeloa District averages 20 in (51 cm) per year. January is normally the wettest month of the year, averaging 4.1 in (10.4 cm) of rain. June and July are the driest months of the year with an average 0.3 in (0.76 cm); however, the months May through September are all nearly void of precipitation, each averaging less than 0.5 in (1.3 cm) of rain each year.

6.2.4 Geology

A general discussion of the geology of O'ahu is presented in Section 2.2.4. Part of the 'Ewa Coastal Plain, the marine and sedimentary rock or caprock at Kalaeloa range from 50 to 400 ft (15 to 122 m) in thickness along the northern boundary and from 750 to 1,000 ft (229 to 305 m) in thickness along the coast. The upper 100 ft (31 m) of caprock is marine sediment, consisting mainly of coral reef limestone with minor layers of shell fragment limestone and beach sands. Beneath this uppermost layer, alternating layers of alluvial and marine sediments are present. Alluvial layers vary from 5 to 95 ft (1.5 to 29 m) in thickness, and consist of poorly sorted clays, silts, sands, and gravels of volcanic origin. The alternating marine layers are somewhat thicker (NAVFAC PAC 1994). In the Kalaeloa area, the caprock is underlain by Wai'anae and possibly Ko'olau volcanic rock.

The coralline limestone unit beneath Kalaeloa contains numerous solution cavities of various shapes and sizes. Many of the cavities have been filled, or partially filled with numerous materials derived from the breakup of old coral reefs and, in places, some cavities have been plugged or partially plugged by stream-laid alluvium derived from the erosion of volcanic and sedimentary rocks. The most unique geological features present at the Navy-retained lands at Kalaeloa are the sinkholes. Sinkholes are natural cavities in the emerged coralline reef that make up much of the 'Ewa Plain. In most cases, these are the actual remnants of the original reef structure that have been enlarged or otherwise structurally altered through solution by groundwater.

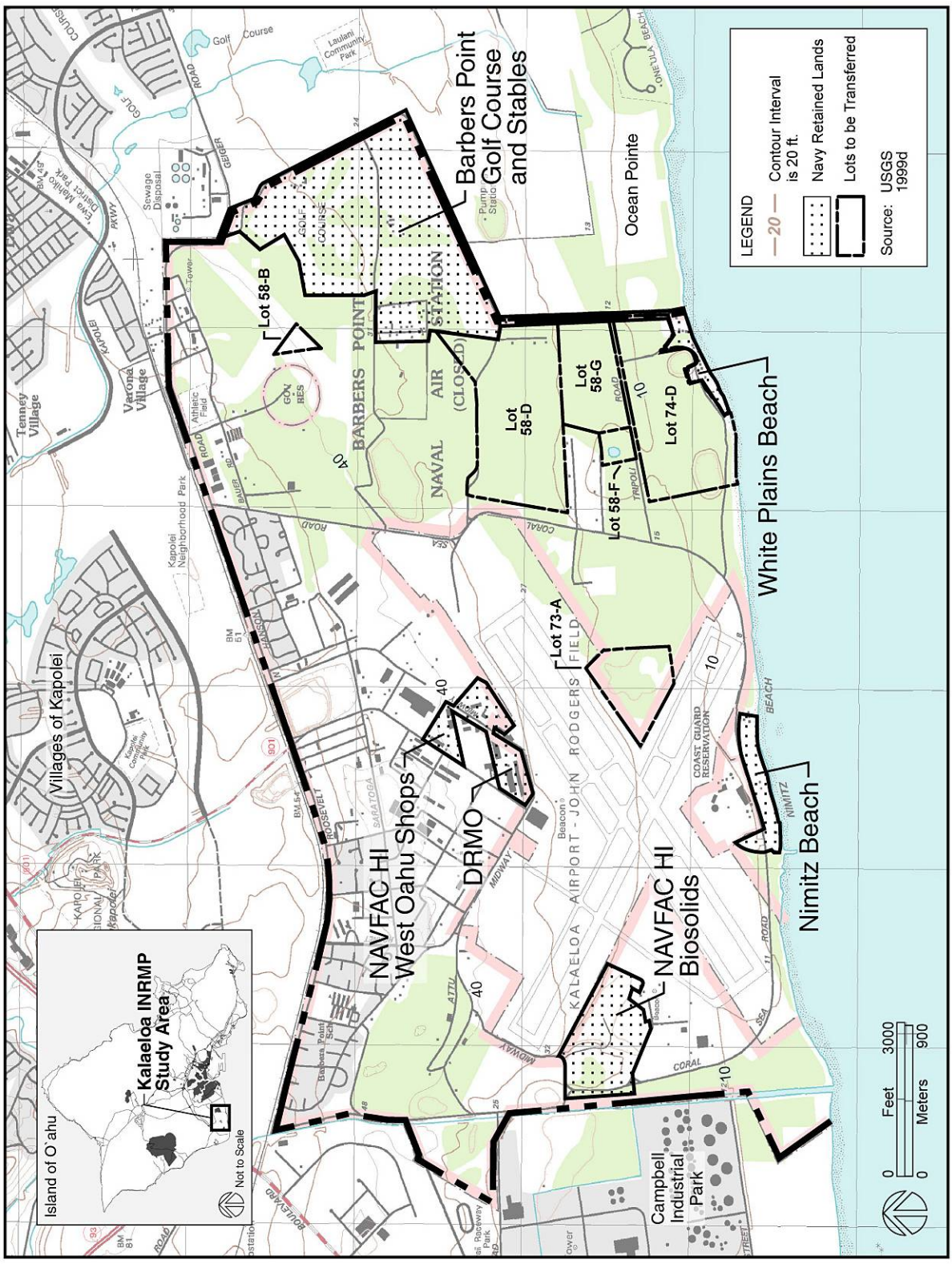


Figure 6-3: Topography, Kalaeloa Study Area

6.2.5 Soils

Figure 6-4 shows the soil types for Kalaeloa and Table 6- 1 provides a summary of the soil types found at Kalaeloa. The majority of Kalaeloa is situated on coral outcrop (CR), with little or no soil cover. The DRMO, West Oahu Shops, and the Biosolids Treatment Facility are underlain by CR (coral outcrop) only. The Barbers Point Golf Course is underlain by MnC as well as CR and FL. Lot 58-F (Triangle) is underlain by FL. The two beach areas (White Plains and Nimitz) are underlain by CR and Beach Sand (BS). The near shore portions of Lot 74-D are underlain by BS.

Table 6-1: Soils, Kalaeloa Study Area

Soil Type	Location	Description	Characteristics
Beaches (BS) occur as sandy, gravelly, or cobbly areas. They are washed and rewashed by ocean waves. BS consists mainly of light-colored sands derived from coral or sea shells.			
Coral Outcrop (CR)	Small areas of CR are exposed on the ocean shore, on the coastal plains, and the foot of the uplands.	Composed of coral or cemented calcareous sand. In a typical profile, CR makes up about 80 to 90 percent of the acreage with the remaining 10 or 20 percent consisting of a thin layer of friable, red soil material in cracks, crevices, and depressions within the coral outcrop.	Soil characteristics were not reported for this soil type.
'Ewa Series: This series consists of well-drained soils in basins and on alluvial fans. These soils developed in alluvium derived from basic igneous rock.			
'Ewa silty clay loam, moderately shallow, 0 to 2 percent slopes (EmA)	This soil type occurs on alluvial fans and terraces.	The surface layer is dark reddish-brown silty clay loam about 18 in (45.7 cm) thick. The subsoil is dark reddish-brown and dark-red silty clay loam that has a subangular blocky structure. The substratum is coral limestone which can be found at 20 to 50 in (50.8 to 1227 cm) depth.	Permeability is moderate, runoff is very slow, and the erosion hazard is no more than slight. The available water capacity is 1.3 in/ft (11 cm/m) in the surface layer and 1.4 in/ft (12 cm/m) in the subsoil.
Fill Land: This land type consists of areas filled with material from dredging, excavation from adjacent uplands, garbage, and bagasse and slurry from sugar mills. A few areas are filled with material from dredging and excavation. Generally, these materials are dumped and spread over marshes, low-lying areas along coastal flats, coral sand, coral limestone, or areas of shallow bedrock.			
Fill land, mixed (FL)	FL occurs mostly near Pearl Harbor and in Honolulu adjacent to the ocean.	Areas filled with material dredged from the ocean or hauled from nearby areas, garbage, and general material from other sources.	Soil characteristics were not reported.
Māmala Series: This series consists of shallow, well-drained soils along the coastal plains. These soils formed in alluvium deposited over coral limestone and consolidated calcareous sand.			
Māmala stony silty clay loam, 0 to 12 percent slopes (MnC)	These soils occur on coastal plains.	Neutral to mildly alkaline, dark reddish-brown stony silty clay loam in the surface layer (~ 8 in [20 cm] thick). The subsoil is neutral to mildly alkaline, dark reddish-brown silty clay loam (~11 in [28 cm] thick). The soil is underlain by coral limestone and consolidated calcareous sand at depths of 8 to 20 in (20 to 51 cm). Stones, mostly coral rock fragments, are common in the surface layer and in profile.	Permeability is moderate. Runoff is very slow to medium and the erosion hazard is slight to moderate. The available water capacity is 2.2 in/ft (18 cm/m) in the surface layer and 1.9 in/ft (16 cm/m) in the subsoil.

Source: USDA 1973; NRCS 2007

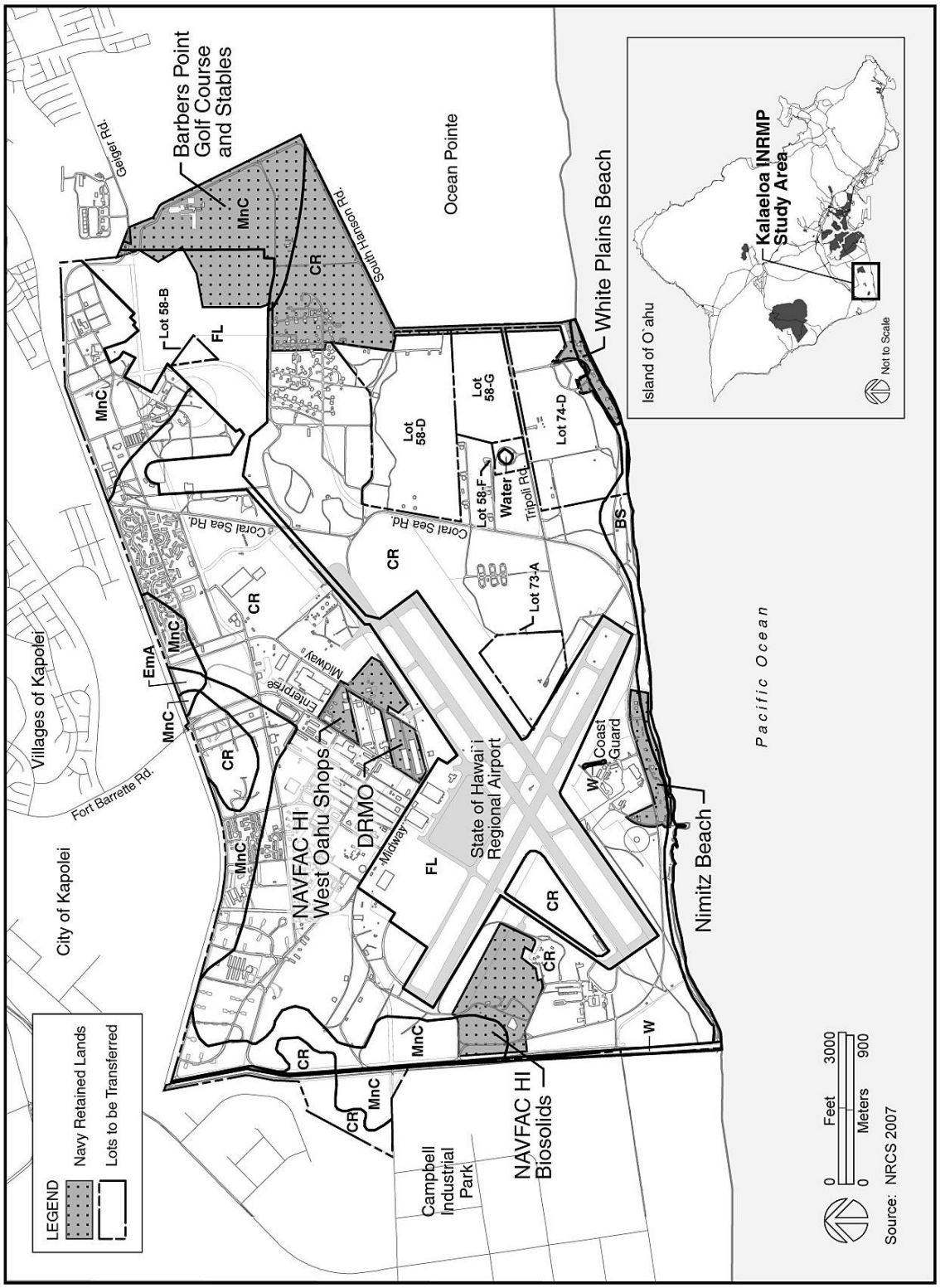


Figure 6-4: Soils, Kalaeloa Study Area

6.2.6 Hydrology

Section 2.2.5 provides a discussion of regional hydrology. The discussion of the hydrology of the Navy-retained lands at Kalaeloa is divided into two subsections: (1) surface water; and (2) hydrogeology.

6.2.6.1 Surface Water Resources

Kalaeloa is located in the Honouliuli and Kalo'i watersheds. The Honouliuli Watershed consists primarily of agricultural and forested land drains the Honouliuli Stream and ultimately discharges to the West Loch of Pearl Harbor; surface water flows in the 'Ewa Beach Watershed similarly drain to Pearl Harbor (NAVFAC PAC 1994).

There are two surface water bodies located within the subject lots: (1) Ordy Pond at Lot 58-F; and (2) Airport Wetland at Lot 73-A. The Ordy Pond is considered a non-jurisdictional wetland (NAVFAC PAC 1994). The pond is a brackish water-filled sinkhole with a depth of 22 ft (7 m). The open water area is approximately 270 ft (82 m) in diameter and accounts for less than 1 ac (0.4 ha). Including the surrounding mangrove, the pond occupies an area of about 3 ac (1.2 ha). The pond's sediment provides a geologic record of sedimentation and climatic change for the leeward region of the island. The pond was originally hydraulically connected to the ocean, although it is now nearly sealed off from groundwater due to the accumulation of fine sediments. As a result, there is very little tidal fluctuation in the pond (DON 2011a).

The wetland at Lot 73-A (Airport Wetland) is a small (less than 1 ac/0.4 ha), seasonal, non-jurisdictional wetland. Lot 74-D (Beach Area) is located immediately adjacent to the Pacific Ocean. The shoreline portions of Lot 74-D (Beach Area) are classified as "marine system, intertidal subsystem" (DON 2011a).

At Kalaeloa, storm water runoff is controlled primarily through diversion to a series of dry wells located throughout the former NASBP (NAVFAC PAC 1994). The Flood Insurance Rate Maps (FIRMs) published by the Federal Emergency Management Agency (FEMA 2011) identifies the majority of the project area within Zone D, that denotes areas in which flood hazards are undetermined, but possible. There are no streams or surface water features in or near the subject lots that could cause potential flood hazards. Kalaeloa is a coastal site at a very low elevation and is vulnerable to tsunami inundation (NAVFAC PAC 1994). However, near shore portions of Navy-retained lands are located in Zone "VE". Zone VE corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves (FEMA 2011). The City and County of Honolulu has established a tsunami evacuation zone that encompasses all of the Nimitz Beach and Cottages, White Plains Beach and Cottages, and Lot 13074-D (up to Tripoli Road) (CCH 2010).

6.2.6.2 Hydrogeology

Section 2.2.5 provides a summary of the four major aquifer types that occur on O'ahu. The vast majority of the Kalaeloa District is within the 'Ewa aquifer system of the Pearl Harbor Aquifer Sector. However, a small portion of the eastern side of Kalaeloa (including portions of the Barbers Point Golf Course, the White Plains Beach and Cottages, Lot 58-D/NTSR, Lot 58-G/STSR, and Lot 74-D/Beach Area) are located within the Waipahu aquifer system of the Pearl Harbor Aquifer Sector. Both aquifer systems have two aquifers: a deep confined aquifer in the underlying basalt and an overlying shallow unconfined caprock aquifer (Mink and Lau 1990).

Both of the deep aquifers are classified as basal, confined, flank aquifers. The 'Ewa aquifer system (30204121 [13213]) is currently used, and has low salinity (250 to 1,000 mg/l Cl^-). It is not a drinking water source or considered ecologically important. It is considered irreplaceable with a low vulnerability to contamination. In contrast, the Waipahu aquifer system (30203116 [12211]) is currently used for drinking water and has low salinity and moderate vulnerability to contamination (Mink and Lau 1990).

Both of the shallow aquifers are basal, unconfined, sedimentary aquifers. The 'Ewa aquifer system (30204116 [13321]) is currently used, and has moderate salinity (1,000 to 5,000 mg/l Cl^-). It is not used for drinking water nor is it considered ecologically important. It is considered replaceable and has a high vulnerability to contamination. In contrast, the Waipahu aquifer system (30203121 [12212]) is currently used, is ecologically important, and has low salinity. It is considered irreplaceable and has a moderate vulnerability to contamination (Mink and Lau 1990).

The depth to groundwater at Kalaeloa ranges from about 60 ft (18.3 m) along the northern border of Kalaeloa, to zero at the coast. These depths correspond to a seaward gradient of 1 to 2 ft per mile (0.2 to 0.4 m/km). The alternating layers of marine and alluvial sediments underlying the coral aquifer are likely saturated with saline water hydraulically connected to the ocean. Hydraulic conductivity with the marine layers is high, allowing horizontal movement of groundwater, but less permeable alluvial layers inhibit vertical migration of groundwater within the caprock as a whole. Hydraulic conductivities of the marine layers are estimated to be on the order of 10^{-3} to 10^{-1} cm per second (cm/sec). Hydraulic conductivities of the volcanic rocks are likely several orders of magnitude lower. These volcanic rock units consist of finely crystalline to glassy basalts, with minor amounts of interbedded welded ashes and alluvial volcanic material. Cooling joints, fractures, lava tubes, brecciated zones, and other depositional features are present within the volcanic rock, resulting in hydraulic conductivities up to 10^{-2} cm/sec (NAVFAC PAC 1994).

The *BRAC Cleanup Plan for NAS Barbers Point, O'ahu, Hawai'i* (DON 1998) indicates that contaminants including petroleum hydrocarbons, pesticides and herbicides, polychlorinated biphenyls, solvents and metals were detected at low concentrations in the groundwater. Sampling indicated that the contaminant concentrations were uniformly distributed across the Kalaeloa District and are considered to be representative of background levels. Although the low contaminant concentrations were not expected to have an impact on regional groundwater quality or to pose significant risk to humans or the environment, sediments with contaminant concentrations exceeding hazardous waste criteria were removed.

A systematic evaluation was conducted of impacts to overall groundwater quality resulting from known or potential sources of groundwater contamination from the former NASBP by the Navy in 1999 (DON 1999). Localized groundwater contamination exists; however, neither extensive nor widespread degradation of overall groundwater quality has resulted from known or potential point sources. The evaluation of risks posed by exposure to groundwater through the assumed exposure pathways (untreated potable water consumption and use) indicates negligible risk to human health. An ecological risk evaluation was completed for potential complete exposure pathways to the aquatic life at Ordy Pond and the Pacific Ocean. Results indicated that risks posed by groundwater discharge to the pond are insignificant and risks posed to aquatic habitats of the Pacific Ocean (by groundwater) are also considered insignificant (DON 1999).

6.3 GENERAL BIOTIC ENVIRONMENT

Information on biological resources presented in this and subsequent sections are primarily derived from surveys of terrestrial plants and animals conducted as part of the INRMP update process and the 1997 NRMP. The reports, listed below, are contained in the appendices.

- Barbers Point Navy-retained Lands Botanical Survey (NAVFAC PAC 2006k) (Appendix E1)
- Botanical Survey of Navy Retention Parcels at Naval Station Barbers Point, O'ahu (Char 2000d) (Appendix E2).
- Survey of Birds for the Integrated Natural Resources Management Plan, O'ahu Complex (NAVFAC Pacific 2006a) (Appendix A8).
- Barbers Point Naval Air Station Botanical Survey Report Checklist (DON 1997) (Appendix E3).
- Barbers Point Naval Air Station Bird Checklist (DON 1997) (Appendix E4).

The discussion of the general biotic environment is divided into five subsections (6.3.1 through 6.3.5): (1) threatened and endangered species and species of concern; (2) wetlands; (3) ecosystems; (4) wildlife; and (5) vegetation.

6.3.1 Threatened and Endangered Species and Species of Concern

This section provides a summary of the federally-listed threatened and endangered species and species of concern at the Navy-retained lands at Kalaeloa. It is organized in two parts with animal species discussed in Section 6.3.1.1 and plant species discussed in Section 6.3.1.2. Table 6-2 provides a listing of the federally-listed threatened and endangered species and species of concern.

Table 6-2: Federally-Listed ESA Species and Species of Concern at Kalaeloa

Latin Binomial	Common Name	Regulatory Status
Himantopus mexicanus knudseni	Hawaiian Black-necked Stilt	E
Monachus schauinslandi	Hawaiian Monk Seal	E (proposed CH)
Chamaesyce kuwaleana	'akoko	E
Achyranthes splendes var. rotundata	round-leafed chaff-flower shrub	E (not on Navy-retained lands)
Capparis sandwichiana var. zoharyi	Pua pio	SOC (not on Navy-retained lands)

E – endangered; T – threatened; CH- critical habitat; SOC – Species of Concern

6.3.1.1 Animals

One federally-listed endangered waterbird, the Hawaiian black-necked stilt (Section 3.3.1.1) has been reported at the Biosolids Treatment Facility, Barbers Point Golf Course (NAVFAC Pacific 2006a), Lot 58F (Ordy Pond), and Lot 73-A (Airport Wetland). They have been observed

feeding and nesting in this wetland during the wetter, winter months when it retains water. When the area dries (when there is no exposed water), stilts leave the area. In addition, Hawaiian black-necked stilts were observed and documented at Ordy Pond (Lot 58-F) in 1993 by USFWS and Navy natural resources personnel during a brief period when portions of the bank of the pond had been cleared of mangrove, allowing the birds to wade in the shallower water at the pond's edge. However, the birds have not been documented at Lot 58-F (Ordy Pond) since. The dense mangrove stands fringing Ordy Pond preclude stilts from reaching the shallower waters at the pond's edge for nesting or feeding.

In addition, Hawaiian monk seals have hauled out at the beaches at Kalaeloa (Figure 6-2). Hawaiian monk seals are further described in Section 3.3.1.1.

6.3.1.2 Plants

The federally-listed endangered plant species, 'akoko (Table 4-3), are known to occur on Lot 58-D (NTSR). Within the lot, the Navy has established a conservation area for the plant species. As of 30 June 2007, 1,414 'akoko were counted within the conservation areas (325 within the conservation islets and 1,089 within a supplemental population). A survey conducted in December 2007 and January 2008 documented 176 plants ranging in height from 6 in to 6 ft (15 cm to 185 cm) outside of the conservation area. The total number of 'akoko in Lot 58-D (NTSR) is estimated to be 1,590 (NAVFAC PAC 2008a).

The federally-listed endangered plant species, the round-leafed chaff-flower shrub (*Achyranthes splendes* var. *rotundata*), is known to occur within the Kalaeloa District but not on Navy-retained land. Pua pio (*Capparis sandwichiana* var. *zoharyi*), an endemic shrub that is a federal species of concern, has been documented along the southern boundary of the Kalaeloa District but not within the Navy-retained lands.

6.3.2 Wetlands

Within the Kalaeloa District there are freshwater wetlands, mangrove swamps, coastal salt flats, and the entire coast line which is a marine wetland with an intertidal subsystem. As described in Section 6.2.6.1, there are two surface water bodies on Navy-retained lands: (1) Ordy Pond at Lot 58-5; and (2) Airport Wetland at Lot 73-A. Neither the Ordy Pond or the Airport Wetland are jurisdictional wetlands. In addition, the coastline at Nimitz and White Plains are marine wetlands classified as "marine system, intertidal subsystem." The western site (Nimitz Beach) is further classified as "seasonal tidal, temporary tidal, hyperhaline, regularly flooded,' while the eastern site (Nimitz Beach) is classified as "unknown, temporary tidal, euhaline, regularly flooded." There are no jurisdictional wetlands on the Navy-retained lands at Kalaeloa.

6.3.3 Ecosystems

The classification of the Kalaeloa District native terrestrial ecosystem is a lowland dry shrubland and grass land (Juvik and Juvik1998).

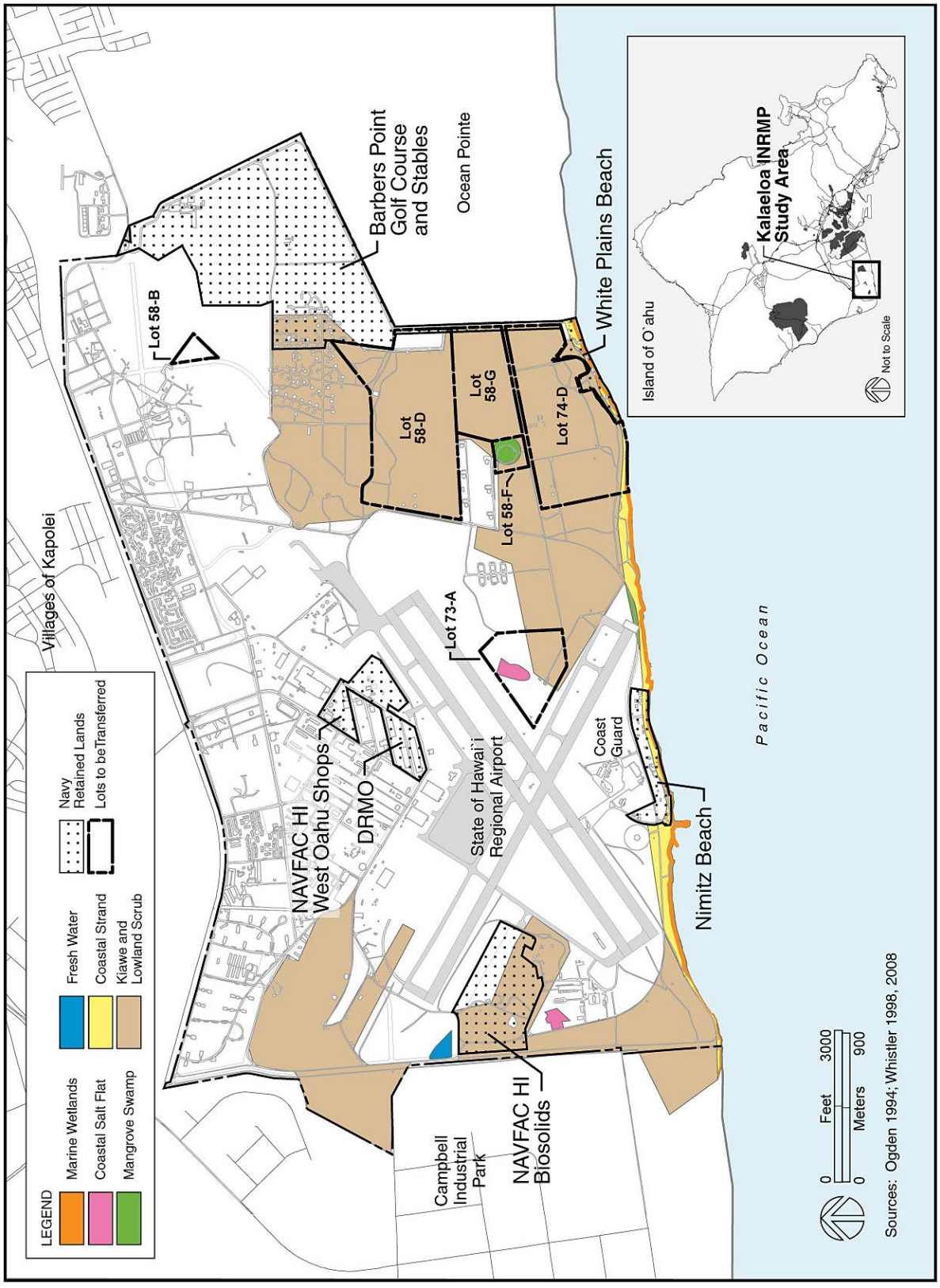


Figure 6-5: Wetlands and Vegetation, Kalaeloa Study Area

6.3.4 Fish and Wildlife

The discussion of terrestrial animals at the Navy-retained lands at Kalaeloa is divided into four subsections: (1) bird species; (2) mammalian species; (3) amphibian and reptile species; and (4) marine animal species.

6.3.4.1 Bird Species

Birds are the dominant wildlife within the Kalaeloa District. One federally-listed endangered bird species (Hawaiian black-necked stilt, Section 3.3.1.1) and five MBTA-protected bird species have been reported at the Navy-retained lands at Kalaeloa (Table 6-2). These birds are described in Section 3.3.4.1, Table 3-7.

Table 6-3: MBTA Bird Species Observed at Kalaeloa Study Area

Common Name	Hawaiian Name	Latin Binomial	Observed in 1984			Observed in 2006			Comments
			BPGC&S	N&WP	BTF	BPGC&S	N&WP	BTF	
Cattle egret		*Bubulcus ibis*	yes	yes	yes	no	no	yes	Introduced
Black-crowned night heron	ʻaukuʻu	*Nycticorax nycticorax*	yes	yes	yes	yes	yes	yes	Indigenous
Pacific golden plover	kōlea	*Puvialis fulva*	yes	yes	yes	yes	yes	yes	Indigenous
Ruddy turnstone	ʻakekeke	*Arenaria interpres*	yes	yes	yes	no	no	no	Indigenous
Wandering tattler	ʻulili	*Heteroscelus incanus*	no	no	no	no	yes	no	Indigenous

Source: NAVFAC Pacific 2006a

BPCG& S – Barbers Point Golf Course & Stables; N&WP – Nimitz and White Plains Beaches and Cottages; BTF – Biosolids Treatment Facility

Appendix E5 provides a listing of the birds recorded for the 1984 and 2006 surveys. The three most abundant species recorded at NASBP in 1984 included zebra doves, Japanese white-eyes, and northern cardinals (Botanical Consultants 1984). The 2006 bird survey focused on three of the Navy-retained lands at Kalaeloa in 2006: (a) Biosolids Treatment Facility; (b) Barbers Point Golf Course; and (c) Nimitz Beach and Cottage/ White Plains Beach and Cottages (combined). The following bullets summarize the common species observed at each of those locations.

- Biosolids Treatment Facility. A total of 16 species were recorded including red-vented bulbuls, Japanese white-eyes, northern cardinals, spotted doves, and zebra doves.
- Barbers Point Golf Course and Stables. The most commonly observed species during the 2006 survey were red-crested cardinals, zebra doves, and red-vented bulbuls.
- Nimitz Beach and Cottages and White Plains Beach and Cottages. A total of 15 species were recorded. A notable addition was a large flock of jungle fowl (*Gallus gallus*) (chickens).

6.3.4.2 Mammalian Species

The only terrestrial mammals observed on Navy-retained lands at Kalaeloa are alien species including: (1) mongooses; (2) feral cats; (3) feral dogs; and (4) several species of introduced rodents. As discussed in Section 6.3.1.1, federally-listed endangered Hawaiian monk seals haul out at the beaches at Kalaeloa.

6.3.4.3 Amphibian and Reptile Species

An amphibian and reptile species survey was not conducted for Kalaeloa; the Navy focused amphibian and reptile species (herpetological) surveys on forested areas where these species are of more interest from an ecological/invasive species perspective.

6.3.4.4 Marine Animal Species

The following is a general summary of the marine animals that are likely to occur offshore. Marine macroinvertebrates, found offshore of Kalaeloa, include reef-building corals, several species of sea cucumber, sea urchins, and colonial soft corals. Marine vertebrates include reef fish, although abundance and diversity are low. The most common are triggerfish (*Balistidae*) and hawkfish (*Cirriridae*). Federally-listed endangered Hawaiian monk seals are sometimes observed offshore of Kalaeloa. The federally-listed threatened green sea turtle is known to frequent the area immediately offshore of Kalaeloa (Section 3.3.1.1). The federally-listed endangered humpback whale (Section 3.3.1.1) may be present in the vicinity from November to May; however, densities of this species offshore of Kalaeloa are among the lowest in Hawai'i.

6.3.5 Vegetation

The Navy-retained lands at Kalaeloa have been previously developed and disturbed. A total of 170 plant species were inventoried at NASBP in 1984 (Botanical Consultants). Fifteen species are endemic, five are of Polynesian origin, and 129 are exotic or alien. Plant species found within Kalaeloa consist mostly of introduced species typically found within urban landscaped areas. The 1984 botanical survey of NASBP described two major vegetation types at Kalaeloa: (1) Kiawe and Lowland Scrub; and (2) Strand Community (Figure 6-5).

The vegetation of most of the undeveloped acreage of Kalaeloa has been described as "kiawe and lowland scrub zone" and a "summer-deciduous scrub forest." These classifications are given to areas below 1,000 ft (304.8 m) in elevation where rainfall is less than 20 in (50.8 cm) per year. These plant communities are dominated by alien vegetation comprised of koa haole, kiawe, and an understory composed of various introduced grasses and forbs (Botanical Consultants 1984). In the areas along the roads or in places that have been graded, ruderal vegetation, primarily grasses and annual or short-lived, weedy species, are predominant.

The second major vegetative zone is the "strand community" which varies in width from 15 ft (4.6 m) at the western boundary of the Navy's Kalaeloa property, to approximately 150 ft (45.7 m) in the vicinity of the campground near Nimitz Beach. The strand component includes many indigenous species including beach naupaka (*Scaevola sericea*), pickleweed (*Batis maritime*), *'*ākulikuli (*Sesuvium portulacstrum*), as well as numerous exotic plant species (Botanical Consultants 1984).

A 2006 botanical survey (NAVFAC PAC 2006k) of the natural areas at Biosolids Treatment Facility, Barbers Point Golf Course, Nimitz Beach and Cottages, and the White Plains Beach

and Cottages is summarized in the following paragraphs. DRMO and the West Oahu Shops consist primarily of improved lands with limited landscaped areas and were not included in the 2006 survey.

6.3.5.1 Biosolids Treatment Facility

The natural areas within the Biosolids Treatment Facility are fragmented by gravel roads and contain old, collapsed concrete structures, metal frames, and other signs of modification. The 2006 botanical survey focused on a small land area at the intersection of Coral Sea Road and Lake Chaplain Street. The vegetation in this area is typical of highly disturbed areas in the 'Ewa Plain. Kiawe and Manila tamarind (*Pithocellobium dulce*) comprise the dominant overstory. The midstory is also typical, containing koa haole, India fleabane and sourbush. 'Ilima and 'uhala are two indigenous species that were observed; both are common in dry, lowland areas in the islands (NAVFAC PAC 2006k).

6.3.5.2 Barbers Point Golf Course and Stables

A 2006 botanical survey focused on the natural areas surrounding the Barbers Point Golf Course and Stables. There are remnant forests along the golf course edge and between the revetments (that comprise the stables) and paddocks; however, this area has been highly altered from its original state. The forest area west of the golf course was surveyed most recently in 2001 (Rivers 2001 in NAVFAC PAC 2006k) and its state was the same in 2006. The area immediately surrounding the stables was surveyed in 2000 by Char (2000d) and 2001, and was also found in the same condition. The overstory vegetation consists primarily of kiawe and Manila tamarind while the midcanopy is koa haole, sourbush, klu (*Acacia farnesiana*) and agave (*Agave sisalana*). There are also small patches of endemic coastal sandalwood (*Santalum ellipticum*) which should be preserved. The ground cover consists primarily of buffelgrass (*Cenchrus ciliarus*) with scattered 'ilima.

The vegetation in the areas adjacent to the horse stables and golf course are consistent with that found in the former Northern Trap and Skeet Range directly to the southwest, which contain the federally-listed endangered 'akoko. However, no 'akoko were observed in this area. This area should be resurveyed using a smaller transect prior to any alteration or development (NAVFAC PAC 2006k).

6.3.5.3 Nimitz Beach Park and Cottages

Nimitz Beach Park is a narrow coastal strip of land, containing cabins, shelters for day use picnic areas, and a restroom. Most of the areas are mowed and developed, with small pockets of forest and coastal strand. The forest is mixed native and non-native coastal vegetation with kiawe, ironwood, milo, and kamani overstory. *Cassytha filiformis* also covers portions of the canopy. The coastal strand includes many common indigenous species including 'ilima, 'uhaloa, naupaka, 'aki'aki, and beach morning glory (NAVFAC PAC 2006k).

6.3.5.4 White Plains Beach Park and Cottages

White Plains Beach Park is a narrow strip of land containing cabins and shelters for day use picnic areas; several buildings used for a bath house/restroom, snack bar and beach rentals; and an area is maintained for tent camping. A mixed native forest and non-native coastal vegetation are found here. The overstory consists of kiawe, ironwood, milo, kamani, and hau. The coastal strand includes common native plant species: 'ilima, 'uhaloa, naupaka, 'aki'aki

(*Sporobolous virginicus*), and beach morning glory (*Ipomoea pes-caprae*). Non-native plant species such as coral berry (*Ravina humilis*), *Portulaca pilosa*, swollen fingergrass, and beggar's tick (*Bidens alba*) were also observed.

An interesting sedge, kaluhā (*Bolboschoenus maritimus paludosus*), was found in a salt marsh at the camping area. The Hawaiian populations of this species are referred to as the indigenous subspecies *paludosus*, characterized by the pale brown glumes and rounded and abruptly contracted spikelet apex (Wagner 1999 in NAVFAC PAC 2006k). Although this species is not federally- or SOH-listed, it is considered rare on O'ahu and its habitat should not be disturbed (NAVFAC PAC 2006k).

6.4 CURRENT MANAGEMENT

6.4.1 Protected-Species and Ecosystem Monitoring and Management

6.4.1.1 Protected Species Monitoring and Management

1. Hawaiian Black-necked Stilt

The Hawaiian black-necked stilt has been recorded at the Barbers Point Golf Course and Biosolids Treatment Facility (Section 6.3.1.1). The Navy has conducted a bird survey of the Navy-retained lands at Kalaeloa (NAVFAC PAC 2006a) and will update this survey in support of future INRMP updates.

2. MBTA-Protected Bird Species

Five MBTA-protected birds have been recorded at Kalaeloa (cattle egret, Pacific golden plover, black-crowned night heron, ruddy turnstone, and wandering tattler) (Section 3.3.3.1). Management actions regarding MBTA-protected bird species at the Navy-retained lands at Kalaeloa include predator control at the White Plains Beach public recreation area and White Plains and Nimitz beach cabin areas and outreach on migratory birds with MWR patrons.

The Navy has provided funding, as part of the JBPHH environmental program, to Wildlife Services for nuisance animal/predator control (primarily trapping and removal of feral cats and dogs) on White Plains Beach, which includes the public beach area and the MWR cabins area, and on Nimitz Beach, which includes the MWR cabins area and the pavilion area.

Outreach includes placing information on migratory birds and the MBTA inside cabins, and funding an information booth or kiosk with volunteers that would be set up during weekends, holidays, or other high usage times in order to educate MWR patrons on interaction with wildlife.

3. Hawaiian Monk Seals

The conservation and management activities at Kalaeloa that provide a benefit to Hawaiian monk seals are the same as those described for PHNC (Section 3.4.1.1). The Navy continues to require that established procedures are followed during amphibious crew inserts. These include having designated look outs watching for other vessels, obstructions to navigation, and marine mammals including whales, monk seals, and sea turtles. Exercise planners are required to review training overlays that identify the insertion points and any nearby restricted areas. All sensitive biological receptors are avoided during training.

There is public access to all Kalaeloa beaches, and the interaction between Hawaiian monk seals and the public in these areas is managed through coordination with the JBPHH environmental program, USDA APHIS Wildlife Servies, federal law enforcement, Navy MMR lifeguards, and NOAA Fisheries.

As stated above, the Navy has provided funding to Wildlife Services for nuisance animal/predator control on White Plains Nimitz Beaches. The Navy will expand Wildlife Services contract in fiscal year 2012 to include monitoring and collecting data on monk seals in these areas. Currently, the beaches along Kalaeloa Navy properties are checked daily for monk seals by NOAA volunteers with the O'ahu Monk Seal Response Team, a volunteer group that assists NOAA's Pacific Island Regional Office (PIRO) and Pacific Islands Fisheries Science Center (PIFSC) in monk seal response issues. The response team identifies and records information on seals that haul out on Kalaeloa beaches, sets up a protection zone to guard them from disturbance while they are resting, and provides public onlookers with information about the Hawaiian monk seal and its endangered status. Additionally, the team monitors pupping events and reports animals in distress (due to hooking, entanglement or otherwise) and will stand by in such instances until help arrives.

The Navy will coordinate with NOAA Fisheries and volunteers with the O'ahu Monk Seal Response Team to ensure that seal monitoring and data collection by Wildlife Services complements the volunteer monk seal monitoring program that is currently in place. Coordination will include working with NOAA Fisheries to determine the types of data that should be collected and arranging for Wildlife Services to receive the appropriate training to collect monk seal data. The NAVFAC HI Natural Resources Program Manager maintains a log book of all sightings of Hawaiian monk seals at Kalaeloa (Appendix B5). The Navy has SOPs related to Hawaiian monk seal haul outs (Appendix I3).

Lifeguards funded through the Navy's MWR program at the White Plains Beach public recreation area monitor the public's interaction with seals that have hauled out on the beach. Lifeguards are present at White Plains beach every day from 0900 to 1700 and help prevent disturbance to seals by intervening to stop the disturbance, and notifying federal law enforcement officers if required. The federal law enforcement office has one officer designated as a JBPHH Game Warden. This officer responds to reports of criminal activity at Kalaeloa and enforces laws which protect the seals.

The Navy will work to limit human interaction with seals in area where lifeguards are not present (beaches fronting the White Plains and Nimitz MWR cabins) through increased outreach efforts within the MWR program. Potential outreach activities include installing signs and/or information panels in the cabin areas, placing information on monk seals inside the cabins, and funding an information booth or kiosk with volunteers that would be set up during weekends, holidays, or other high usage times in order to educate MWR patrons on human/monk seal interaction.

The coordination between Navy, NOAA Fisheries, volunteer groups, and law enforcement and the overall plan for protecting Hawaiian monk seals at Kalaeloa is an adaptive and evolving strategy. The effictiveness of the arrangement and interaction between all parties involved and the adequacy of the allocated funding is revisited each year as part of the annual JBPHH INRMP review. This is particularly important due to the increasing popularity of beach areas at Kalaeloa and the increasing frequency of Hawaiian monk seals in these areas. If current practices are ever deemed inadequate, then new solutions for protecting seals will be sought after and pursued.

4. 'Akoko

Lot 58-D. As part of a contaminant removal action in 2003, approximately 23 ac (9.3 ha) of Lot 58-D (NTSR) were scraped and the top layer of soil and substrate were placed in a landfill. Formal Section 7, ESA consultation with USFWS completed on June 5, 2003, concluded that the action would not likely jeopardize the continued existence of 'akoko. However, Navy agreed to undertake the following conservation actions for a period of five years to achieve specific goals to decrease adverse impacts on the plant:

- Suffer no net loss in the number of adult 'akoko plants as a result of the cleanup action.
- Reestablish a viable seedbank at each site where out-planting will occur.
- Establish *ex-situ* collection of 'akoko seeds that represent the genetic diversity of the existing, pre-cleanup, (NTSR) population.
- Maintain an average of 300 or more adult, self-sustaining and reproducing individuals at each of two sites (a total of 600 such plants) over the five-year period. One of the two sites was established in Lot 58-D (NTSR), the other at the USFWS Kalaeloa Wildlife Refuge. At the end of the five-year period, the 300 or more plants at each of the two sites are to be self reproducing (i.e., reproducing without supplemental care).
- Maintain or establish a minimum total of 100 adult, self-sustaining and reproducing 'akoko plants within the eight "islets" in the cleanup area.

The conservation plan's term expired on September 31, 2008.

Barbers Point Golf Course and Stables. The vegetation in the natural area adjacent to the Barbers Point Golf Course and Stables is similar to the habitat of the former NTSR (Lot 58-D) which contains the federally-listed endangered plant species 'akoko (Section 6.3.3.2). The 2006 botanical survey recommended that an 'akoko botanical survey with a more intensive transect be done prior to any disturbance or development in this area (NAVFAC PAC 2006k).

6.4.1.2 Access Restrictions

The Navy continues to prohibit training in areas marked by signs or fences indicating the presence of rare and/or protected species. The Navy continues to prohibit bivouacking within 3,280 ft (1,000 m) of posted signs marking the presence of rare and/or protected plant and animal species or restoration projects. No training units larger than 30 persons (platoon size) are allowed to bivouac outside of reusable bivouac sites provided with portable or reusable latrines. No open fires, burying, or leaving of trash, food preparation, cutting, or clearing of vegetation, or disturbing of vegetation including mosses, grasses, shrubs, bushes, and trees are allowed during bivouacking. All Navy training activities at Kalaeloa are performed in accordance with all applicable biological opinions and existing USCG regulations. Areas known to contain protected species including 'akoko shrub and round-leafed chaff flower are avoided during Navy training exercises at Kalaeloa. Any potential impacts to listed bird species such as the Hawaiian stilt would be addressed through coordination and/or consultation with USFWS.

6.4.1.3 Invasive Species Prevention and Control

As defined by EO 13112 an invasive species is an alien (non native) species whose introduction does or is likely to cause economic or environmental harm or harm to human health. The Navy requires decontamination (cleaning) of all vehicles, equipment, personal gear, shoes, and clothing before personnel may enter a training area at PHNC in order to minimize the introduction of invasive species to Kalaeloa and other Navy lands.

6.4.1.4 Natural Resources Restoration

There are no current natural resources restoration management actions at the Navy-retained lands at Kalaeloa.

6.4.1.5 Wetlands

The JBPHH IEPM ensure that there is no net loss of wetlands on Navy-controlled lands, while simultaneously establishing and/or enhancing native wetland species and reducing alien wetland species. The Navy provides for formal wetland training for NAVFAC HI, and NAVFAC PAC natural resources and environmental staff. The Navy conserves and protects the marine wetlands located at Nimitz and White Plains Beaches (Section 6.3.2).

6.4.2 Natural Resources Studies

NAVFAC PAC completed a bird survey of Kalaeloa in 2006 (Section 6.3.4.1) (NAVFAC PAC 2006a). The Navy intends to periodically update the bird survey for the installation in support of future INRMP updates.

NAVFAC PAC completed a botanical survey of Kalaeloa in 2006 (Section 6.3.5) (NAVFAC PAC 2006k). This survey updated the 2000 survey conducted by Char (Char 2000d). The Navy intends to periodically update the botanical survey for the installation in support of future INRMP updates.

6.4.3 Use of Geographic Information Systems

NAVFAC HI staff continually maintain their GIS database to include the locations of protected plant and animal species at Kalaeloa. This updated GIS layer will include the federally-listed bird species (Hawaiian black-necked stilt), MBTA-protected bird species, and vegetation types.

6.4.4 Forestry

There are no current forestry management actions at the Navy-retained land at Kalaeloa. There are small pockets of non-native forests on portions of the Navy-retained land at Kalaeloa; however, the size of these forested areas does not warrant a forestry program.

6.4.5 Community Outreach

Currently, there are no community outreach natural resources management actions at the Navy-retained land at Kalaeloa.

6.4.6 Outdoor Recreation

Nimitz Beach and White Plains Beach are open to the public for outdoor recreation including swimming, surfing, beach walking, and fishing. Additionally, the flat topography at Kalaeloa renders the area ideal for riding bicycles. Although the Navy maintains cabins at both beaches for recreation purposes to MWR-authorized patrons, these cabins are not considered to be part of the outdoor recreation activities covered under this INRMP.

6.4.7 Land Management

Ongoing land management programs at the Navy-retained lands at Kalaeloa are similar to those discussed in Section 3.4.7. They include base planning, reduction of point source pollution, utilization of BMPs during earthwork and construction and storm drain design, non-point source pollution prevention for JBPHH. In addition, the Navy prohibits vehicle traffic off existing roads, use of rocks from rock piles or walls for training purposes, establishment of new vehicle tracks during troop maneuvers. In addition, during maneuvers, digging, including entrenchments and foxholes, are prohibited, except in areas specifically designated by exercise planners. No new placement of barbed wire or concertina wire near signs marking the presence of sensitive ecological areas or fences are allowed by troops during maneuvers. No road, trail, or fire break clearing is allowed during maneuvers without permission from exercise planners. No grading or construction of buildings or other permanent structures is allowed without permission from exercise planners.

In addition, as discussed in Section 3.4.7, the Navy continues to include native plants in landscape design at Navy-retained lands at Kalaeloa.

6.4.8 Floodplains

As described in Section 6.2.6.1, Kalaeloa is a coastal site at a very low elevation and is vulnerable to tsunami inundation (NAVFAC PAC 1994). Other than the land management practices described in Section 6.4.7, there are no specific floodplain management actions at Kalaeloa. CCH maintains a civil defense siren system within the Kalaeloa District which would alert beach goers in the event of a tsunami warning or threat.

6.4.9 Law Enforcement

The Navy-retained lands at Kalaeloa are policed by federal law enforcement officers. The non-Navy lands at Kalaeloa are patrolled by HPD.

6.4.10 Wildland Fire

Wildland fires have impacted unused and/or undeveloped portions of Kalaeloa in recent years; the FFD in coordination with the HFD responds to any fires at Navy-retained lands. In case of fire during troop training exercises, all fires will be reported to the FFD and troops will stop training and begin to fight the fire. Troops will continue to fight the fire until released by the fire department.

6.4.11 Leases and Encroachment Management

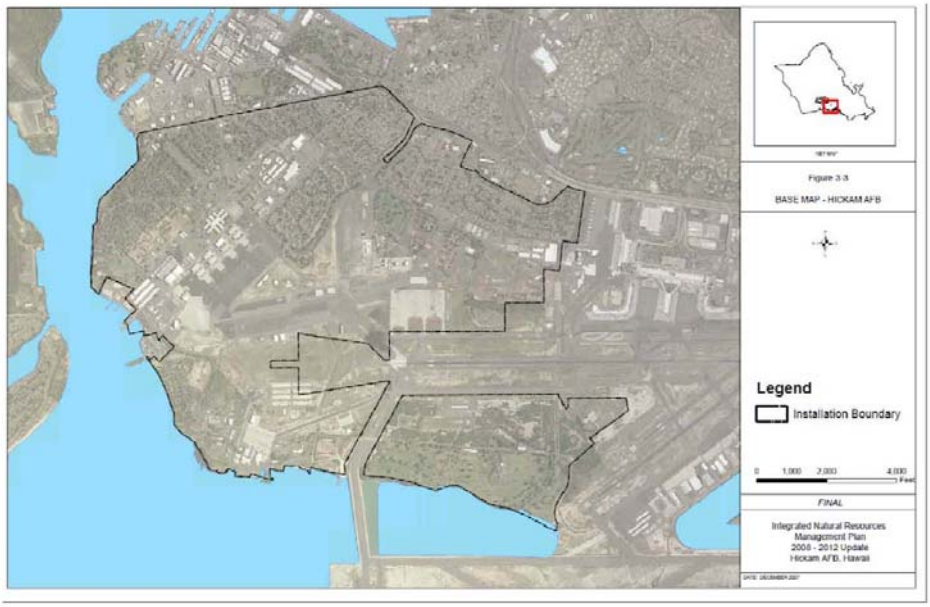
Not applicable.

CHAPTER 7

HICKAM AFB-POL PIPELINE INRMP INSERT

CHAPTER SEVEN: HICKAM AFB-POL PIPELINE INRMP INSERT

The following text includes excerpts from the 2007 INRMP that included Hickam AFB and the POL pipeline (USAF 2007).



3.1 HICKAM AFB

Hickam AFB is the home of the 15th Airlift Wing (formerly designated as the 15th Air Base Wing, until April 2003), which is directly responsible for implementing the INRMP. Hickam AFB also houses about 140 tenant units, including the Hawaii Air National Guard. Base operations support air transport and other activities in the Pacific and Far East.

3.1.1 Location

Hickam AFB is located on the Leeward side of the Koolau Range, on the island of Oahu, Hawaii. The base is bound on the east by the Honolulu International Airport, and the two installations share some of the same runways. The base is bordered on the south by the Pacific Ocean (Mamala Bay), on the west by the entrance to Pearl Harbor, and on the north by the Pearl Harbor Naval Reservation and commercial and industrial land. An enclosed lagoon, referred to as Reef Runway Lagoon, was formed by the construction of the Reef Runway and the associated taxiway off the southwest shore of Hickam AFB. Hickam AFB occupies approximately 2,520 acres (including Fort Kamehameha, acquired from the United States Army in March 1993) (Moreira 2006).

3.1.2 History

Fort Kamehameha, a former Army facility within the boundaries of Hickam AFB, dates back to 1917, when the Army Signal Corps received the first aviation units in Hawaii (Funderburg 1979). In 1934, Hickam Field was established when the Quartermaster Corps carved an airfield out of 2,400 acres of tangled brush and sugarcane fields (15 ABW undated). Hickam Field was officially activated in 1938 to meet the need for additional airfields in

Hawaii. Due to heightened world tension prior to the outbreak of World War II, U.S. defense plans included the increased use of military bases on Oahu, and during World War II Hickam became the hub of the Pacific aerial network.

Hickam Field became Hickam AFB in 1948. After World War II, the Air Force in Hawaii consisted of the Air Transport Command and its successors, the Military Air Transport Service (MATS), the Military Air Command (MAC), and the Air Mobility Command (AMC) (EA 1994a). The permanent base population and mission of Hickam AFB have been relatively steady over time, with the major changes being the number of aircraft services, fuel usage, and transient population levels, all of which peaked during the Korean conflict and again during the Vietnam War era. MATS drew its biggest assignment during the Korean conflict, when its aircraft, augmented by chartered commercial aircraft and a Canadian air transport squadron, carried 559,000 passengers (including 62,000 air evacuation patients); 67,000 tons of cargo; and 30,050 tons of mail in 35,000 Pacific crossings via Hickam AFB (EA 1994a).

3.1.3 Military Mission

In support of past and current activities, land uses that the base contains are military, industrial, administrative, commercial, residential, and recreational in nature. The close proximity of the various land uses creates a complex community of military and non-military personnel. In fiscal year 2001 there were 4,395 active duty Air Force personnel at Hickam AFB. The Air National Guard/Reserves had an additional 2,408 personnel at Hickam AFB (15 CES/CEVR 2002).

Base operations have consistently supported the movement of troops and material from the mainland to the Far East. Military transport aircraft is the primary type flown from Hickam AFB. The aircraft have traditionally been transient; that is, not assigned to Hickam AFB. Figure 3-3 is a base map of the installation.

The current missions of Hickam AFB and its major tenants are listed below.

3.1.3.1 15th Airlift Wing

The 15th Airlift Wing (15 AW) provides command functions to operate and maintain Hickam AFB as well as other outlying installations. The 15 AW also provides worldwide airlift to the commander, United States Pacific Command, and the commander, Pacific Air Forces. In addition, the wing provides en route support and customer service to all aircraft that transit Hickam AFB while maintaining operationally ready forces. Since February 2006, Hickam AFB has become a Pacific Mobility Hub with the arrival of eight C-17 Globe Master III aircraft. 15 AW also provides base and logistic support to more than 140 tenants, including Headquarters Pacific Air Forces in Hawaii, and at other locations in the Pacific. 15 AW supports more than 8,000 Air Force personnel, both military and civilian, plus some 7,000 dependent family members. Of these, more than 4,000 are assigned to 15 AW at various locations.

15 AW supported the Apollo astronauts in the 1960s and 1970s; POW Homecoming, Baby Lift, and New Life in the 1970s; the Eniwetok Atoll Radioactive Cleanup Operation from 1977 to 1980; NASA's space shuttle missions in the 1980s; and the Mount Pinatubo evacuation in 1991 (EA 1994a).

3.1.3.2 Headquarters Pacific Air Forces

Headquarters, Pacific Air Forces' (PACAF) primary mission is to plan, conduct, and coordinate offensive and defensive air operations in the Pacific and Asian theaters. This Major Command maintains combat capability and security in the Pacific region with approximately 400 aircraft, including air-superiority F-15C/Ds, F-15Es, multi-role F16s, OA-10s, KC-135s, C-130s and E-3 Airborne Warning and Control Systems (AWACS) aircraft. More than 44,000 Air Force military and civilian personnel are assigned to PACAF at the major installations in Hawaii, Alaska, Guam, Japan, and the Republic of Korea.

3.1.3.3 715th Air Mobility Operations Group (HQ)

The 715th Air Mobility Operations Group (715 AMOG) was activated 1 July 1994 as part of the en route system organization and represents 15th Air Force and Air Mobility Command in supporting air mobility missions transiting the Pacific Theater. Six air mobility support squadrons (AMSs), 2 detachments and 5 contract air terminal operations in the Pacific are responsible to the group as they direct Air Mobility Control Centers, aerial port operations, aircraft maintenance, and forward supply support. There are 2,064 personnel authorized in the 715 AMOG. The squadrons are located at Yokota and Kadena Air Base, Japan; Osan Air Base, Republic of Korea; Anderson Air Force Base, Guam; and Hickam Air Force Base, Hawaii.

This new en route system provides in-place peacetime air mobility support to the U.S. Pacific Command (PACOM) Theater. The AMSs are sized and structured for peacetime workloads with limited surge and mobility capability. Wartime response or sustained peacetime contingency operations such as disaster assistance, humanitarian operations, and famine relief will require AMC to operate the en route support structure at an increased tempo, or even at locations not associated with the en route structure. Consequently, in concert with the 615th Air Mobility Group at Travis AFB, Global Reach Laydown will provide the capability to lay down an augmented and/or extended en route structure in response to taskings beyond the capabilities of the currently sized en route system. The en route system, expanded by Global Reach Laydown when necessary, provides AMC the ability to respond across the entire spectrum of operations.

The 715 AMOG headquarters is authorized 34 personnel and provides the Pacific en route structure a theater focus and policy guidance through administrative, financial management, command and control, civil engineering, communications, contracting, intelligence, safety, logistics, and transportation staff support. The area of responsibility for the 715 AMOG stretches from Hawaii, north to Alaska, reaching as far west as Diego Garcia in the British Indian Ocean Territory; and back down under encompassing Australia and New Zealand. The area, which includes the Pacific Rim economic region and military powers such as China and North Korea, highlights strategic importance and the need for robust air mobility.

3.1.3.4 735th Air Mobility Squadron (735 AMS)

The 735 AMS provides en route support for all aircraft transiting Hickam AFB. The Group is responsible for the aircraft maintenance, configuration, and command, as well as control and servicing, of C-5, C-17, C-141, C-130, KC-

10, and KC-135 aircraft. This Group annually moves more than 153,000 passengers and more than 37,000 tons of cargo, and participates in over 12,000 air mobility missions.

3.1.3.5 735th Logistics

The 735th Logistics provides dependable logistics support for all AMC and theater airlift en route mission aircraft transiting Hickam AFB, including C-5, C-141, C-17, KC-10, KC-135, and C-130 aircraft; provides support for aircraft carrying foreign heads of state as well as other command and commercial aircraft, including DC-8, L-1011, DC-10, and B-747 aircraft; provides Maintenance Recovery Team (MRT) personnel for disabled aircraft throughout the Pacific theater; support Det-1, 735 AMS, at Richmond RAAF Station, Australia; and to host and train USAF Reserve and Air National Guard forces.

3.1.3.6 735th AMS Aerial Port

The 735 AMS Aerial Port Flight is one of six AMC aerial ports in the Pacific Theater of operations. Their purpose is to uphold AMC's Global Reach mission by providing world-class support to AMC aircraft. Personnel are broken up into 6 major sections, including the Air Terminal Operations Center (TRO), Aircraft Services (TRK), Fleet Service (TRF), Passenger Reservation Center (TRR), Passenger Service (TRP), and Aerial Port Management Staff (TRS).

3.1.3.7 Hawaii Air National Guard

Hawaii Air National Guard (HIANG) is composed of the Hawaii Air National Guard Headquarters, the 154th Group, the 201st Combat Communications Group, and the 199th Weather Flight. They have a two-fold mission: (1) in the state of Hawaii, HIANG is responsible for providing trained units to protect Hawaii's people, preserving peace, and ensuring public safety in response to natural or human-caused disasters, and (2) for federal purposes, HIANG is tasked with providing operationally ready combat units, combat support units, and qualified personnel for active duty in the USAF in time of war or national emergency. HIANG aircraft include eight C-17s, nine KC-135s, and fifteen F15s.

3.1.3.8 Joint Intelligence Command, Pacific

The mission of the Joint Intelligence Command, Pacific (JICPAC) is to provide and disseminate accurate and timely all-source, fused intelligence to the U.S. Commander in Chief, Pacific Forces, joint task force commanders, and their assigned forces.

3.1.3.9 Army Air Force Exchange Service

The primary mission of the Army Air Force Exchange Service (AAFES) is to provide patrons with the quality merchandise and services of necessity and convenience at uniformly low prices. The secondary mission is to generate earnings in support of Morale, Welfare, and Recreation (MWR) programs.

3.1.4 Community Profile

The island of Oahu consists of 46 Census Designated Places (CDPs), which have been delineated cooperatively by state and local officials and the Census

Bureau. These areas are statistical entities comprised of densely concentrated areas of populations that are not in incorporated places, but are locally identified by a name (Census 2000). The CDPs neighboring Hickam AFB are Aiea, Halawa, Hickam Housing, Pearl City, Waimalu and Waipahu. These community areas have had strong military interactions since before 1940, and the military currently employees many residents of the Hickam AFB community area. As of 2001 the total manpower of Hickam AFB was 4,681.
The total population of Hickam AFB community areas was 121,836 people in 2000, which amounted to 14 percent of the population of Oahu (Census 2000). In 2000 about 55 percent of the total population of the community areas was Asian, 19 percent white, and 8 percent Native Hawaiian or Pacific Islander. Of the total population in the Hickam AFB community areas, approximately 16 percent did not speak English very well, 83 percent were high school graduates, and 22 percent had a Bachelor's degree or higher level of education.

The labor force of the Hickam AFB community areas consisting of those persons 16 years and older, amounted to 62,943 people (Census 2000). Eleven percent of that labor force was employed by the armed forces. Of the other employed civilian residents in the Hickam AFB area, 18 percent were employed in the educational health and social services field. About 13 percent were employed in retail trade and 5 percent were employed in other services. Approximately 12 percent were employed in public administration and 7 percent were employed by transportation. Only 1 percent of the area residents were employed in agriculture, forestry, and fishing.

Beginning at the southeast extent of the base on Mamala Bay and working in a counter-clockwise direction, the first adjacent land use bordering the base is the Honolulu International Airport. Hickam AFB and Honolulu International Airport are separated for most of their shared boundary by a drainage canal, although much of the canal flows through culverts under the runways and taxiways that are shared by the two air facilities. Land uses on either side of the property boundary are mostly dedicated to air transport, although there are golf courses, outdoor recreation, residential neighborhoods, warehousing, and munitions storage and handling on the Hickam AFB property nearby.

Continuing north around the Hickam AFB periphery is the boundary with the Kamehameha Highway (U.S. Interstate H1) where it intersects the Nimitz Highway (Hawaii 99). Across the highways are the Camp Catlin Naval Reservation and the Aliamanu Military Reservation. These military reservations include suburban-style housing developments, a golf course, six schools, and a large commercial area. Access to most of the Navy property is unrestricted. Between Hickam AFB and the freeway is a community zone that is composed of public schools, play fields, several churches, church schools, and a county firefighter training center.

Moving west from the freeway interchange, the Hickam AFB property abuts the Pearl Harbor Naval Reservation. The boundary between Hickam AFB and Pearl Harbor Naval Reservation divides Naval housing, schools, and administrative areas from Hickam AFB housing and schools for much of its length. However, on the western end of the common boundary the Pearl Harbor Naval Shipyard is a heavy maritime industrial zone which is across the

road (and a gated fence) from Hickam AFB residential and school zones. West of that boundary is the dredged entrance to Pearl Harbor.

3.1.5 Natural Area Profile

Being on the Leeward side of Oahu, Hickam AFB has relatively low precipitation for Hawaii, averaging 22 inches annually. Hickam AFB is surrounded by primarily urban areas, with a small number of natural areas scattered within a few miles of the installation. The Keehi Lagoon Beach Park is about 2 miles southeast of Hickam AFB along H1, and the Sand Island State Recreation Area is about 4 miles southeast, near the U.S. Coast Guard Reserve on Sand Island. The Sand Island State Recreation Area is a 140-acre park, with 14 acres landscaped with picnic and playground facilities. It is a popular fishing spot for the local population (Bisignani 1993). Salt Lake is about 2 miles east of Hickam AFB, and is surrounded by urban areas and the military reservations which neighbor Hickam AFB on that end. The Ewa Forest Reserve and Keaiwa Heiau State Recreation Area are about 4 miles northeast of Hickam AFB and are part of the Koolau Range. Keaiwa Heiau State Recreation Area offers campgrounds (by free permit) and hiking trails for use.

3.3 HICKAM POL PIPELINE

Hickam POL Pipeline is no longer in service but the two major fuel storage annexes (FSAs), Kipapa FSA and Waikakalaua FSA, are managed by 15 AW. These facilities are in the process of being decommissioned. The two FSAs associated with the pipeline represent one of the five installations covered in this INRMP, although they are frequently discussed separately.

3.3.1 Location

The Hickam POL Pipeline extends from the Schofield Plateau in Central Oahu, between the Waianae and Koolau mountain ranges, to the Pearl Harbor area, on the broad coastal plain of southern Oahu. It is 28.3 miles long and traverses diverse terrain, from forested and vegetated rural areas to highly urbanized areas. The original POL Pipeline consisted of two separate 10-inch lines running south and east from the Waikakalaua Fuel Storage Annex (FSA) and continuing south through what is now the Mililani residential area. A total of 35 valve pits (VP), small structures containing valves used to route fuel flow, are located along the POL Pipeline. The two lines from the Waikakalaua FSA meet in the middle of Mililani Town at VP No. 13, and generally follow Kamehameha Highway southeastward. At Kipapa Gulch a single trunk line extends from the main POL Pipeline into the gulch, connecting with the Kipapa FSA. The parallel lines continue southeast from Kipapa, through the residential areas of Waipio and Crestview, and down to the base of Pearl City Peninsula. The POL Pipeline goes in two separate directions at VP No. 28.

One line continues southward through the Pearl City Peninsula, terminating at VPs No. 31 and 32, located at Victor Dock (Pearl Harbor). In 1955, this pipeline was extended from Victor Dock along the bottom of the Pearl Harbor Middle Loch, surfacing at Beckoning Point on the Waipio Peninsula. The line extends along the peninsula, reenters Pearl Harbor at Waipio Point, and resurfaces at Hickam Pier, where it connects to the Hickam POL lines at VP No. 35.

The other fork heads eastward from VP No. 28, along Kamehameha Highway, circling Pearl Harbor through the residential areas of Pearl City, Waimalu, and

Aiea. This section skirts the main Pearl Harbor Naval Base and connects to a valve pit for tanker unloads at Hickam AFB.

Because the pipeline traverses public and private properties not managed by the Air Force, the focus of this INRMP is on the two FSAs at Kipapa and Waikakalaua. The 15 AW is responsible for land management at these two facilities.

3.3.1.1 Kipapa FSA

The Kipapa FSA is located in Kipapa Gulch, approximately 3 miles southeast of Wheeler AAF.

Kipapa Gulch is approximately 160 feet deep and 500 feet wide in the vicinity of the facility. The FSA extends across most of the gulch and approximately 2,000 feet down the gulch. The total area of Kipapa FSA is 54.7 acres (Goo 2002). A restricted road accesses the site from a residential area immediately above the gulch. A portion of the facility is fenced and has a locked gate. Kipapa stream is a perennial stream that flows through the site outside of the fenced area.

3.3.1.2 Waikakalaua FSA

The Waikakalaua FSA is located approximately 1 mile south of Wheeler AAF. Waikakalaua FSA occupies 28.2 acres (Goo 2002) on a very gently sloping plain of the central Schofield Plateau of Oahu. A pineapple field is located immediately north of the facility at approximately the same elevation as the facility. The terrain falls off sharply from the western side into a small gulch and from the southern and eastern sides into Waikele Gulch.

3.3.2 History

Designed in 1939 and completed in 1943, the Hickam POL Pipeline facilities were originally intended to provide long-term storage and transmission of fuel to Hickam AFB and Wheeler AAF during World War II. Originally, aviation gas (AVGAS) and automotive gas (MOGAS) were distributed through two parallel 10-inch steel pipelines which connected the FSA facilities with Victor Dock. By 1945, the POL Pipeline was transporting 20 million gallons of AVGAS and 6 million gallons of MOGAS per month. MOGAS was phased out of the POL Pipeline system in the 1960s, and JP-4 jet fuel gradually replaced AVGAS. The conversion was complete in 1971. In 1992, JP-8 jet fuel was included in the system. The Hickam POL Pipeline was in use from 1943 until it was taken out of service in March 1993.

Until 1961, the FSAs at Kipapa and Waikakalaua were supplied by tankers directly from the Pearl Harbor dock facilities. In 1960, the Standard Oil of California (SOCAL) Refinery, located at the Campbell Industrial Park on the southwest point of Oahu, was connected to the pipeline, and in 1971 the Hawaii Independent Refinery (HIR) was connected. These refineries were capable of pumping directly into the FSA facilities at a rate of approximately 73,000 gallons per hour (USGS 1990).

3.3.3 Military Mission The POL Pipeline system has over 25 million gallons of storage capacity, most of it at the Kipapa and Waikakalaua FSAs. Approximately 18 billion gallons of fuel flowed through the pipeline during its lifetime. Several other features are included as part of the POL facilities in the vicinity of the FSAs (USGS 1987). These consist primarily of 4- and 6-inch pipelines connected to a variety of underground storage tanks (USTs).

A plan to decommission the POL Pipeline was prepared by the U.S. Army Corps of Engineers in May 1995. Currently, the Hickam POL fuel system is being thoroughly cleaned but no closure/decommissioning related activities, such as demolishing valve pits, grouting pipeline, and sealing tunnels, are being done. All 13 USTs and 20 miles of pipeline are being cleaned. A future project will address the closure aspect of the system (McComb 2002).

3.3.3.1 Kipapa FSA

The Kipapa FSA consists of four horizontal steel USTs which were dug directly into the wall of Kipapa Gulch on 57 acres (Goo 1997, 2002). Each steel UST is 22 feet in diameter and 980 feet long, had an original capacity of 2.4 million gallons, and was used for the storage of AVGAS and, later, JP-4 jet fuel. The Kipapa FSA was connected to the main POL Pipeline at VP No. 17.

Of the four horizontal USTs located at Kipapa FSA, tanks 3 and 4 were emptied and taken out of service in 1984, while tanks 1 and 2 were emptied and taken out of service in February 1992. The facility is no longer used or occupied. There is one standing building on the installation and the foundation remains of another building. In addition, there are several small structures associated with the fuel storage facility. Fuel leaks and sludge management operations have left residual materials that need to be cleaned up. Remediation is being addressed by the Environmental Restoration Program.

Figure 3-5 is a base map of the installation.

3.3.3.2 Waikakalaua FSA

The Waikakalaua FSA consists of nine vertical cylindrical steel USTs arranged in a large circle, connected by aboveground piping (which replaced underground distribution lines) on 34 acres (Goo 1997). Each tank has a diameter of 100 feet and a total depth of 30 feet, and each was originally capable of storing 1.75 million gallons of fuel. A small (500-gallon) aboveground surge tank is also located at the FSA. These USTs were formerly used to store MOGAS and AVGAS. In June 1993, all of the tanks at the FSA were pumped out, except for Tank No. 7 which contained approximately 10,000 gallons of JP-4 jet fuel (USACOE 1995b). The fuel has since been removed and the tank cleaned. Currently, all tanks are out of service, and remedial investigations and cleanup (bioventing) are underway.
Figure 3-6 is a base map of the installation.

3.3.4 Community Profile

The CDPs associated with the Hickam POL Pipeline are Aiea, Halawa, Iroquois Point, Mililani Town, Pearl City, Waimalu, Waipahu, Waipio, and Waipio Acres. These community areas have had strong military presence since before the 1940s. Some portions of the POL Pipeline traverse both public and private property, including residential areas. The Kipapa and Waikakalaua FSAs are both within the Mililani community area.

The 2000 total population for the POL Pipeline CDPs was 164,405. The POL Pipeline community areas were 54 percent Asian, 7 percent Native Hawaiian or Pacific Islander and 16 percent white at the time of the 2000 Census. Thirteen percent of the 2000 POL Pipeline CDPs population did not speak English, 83 percent were high school graduates, and 24 percent had a Bachelor's degree or higher level of education.

The labor force of the POL Pipeline community areas was 87,565 people. Nine percent of the POL Pipeline community area's labor force was employed by the armed forces at the time of the 2000 Census. Of the other employed civilian residents 15 percent were employed in education, health and social services, about 10 percent in public administration and less than 1 percent of the areas residents was employed in agriculture, forestry and fishing.

3.3.5 Natural Area Profile

3.3.5.1 Kipapa FSA

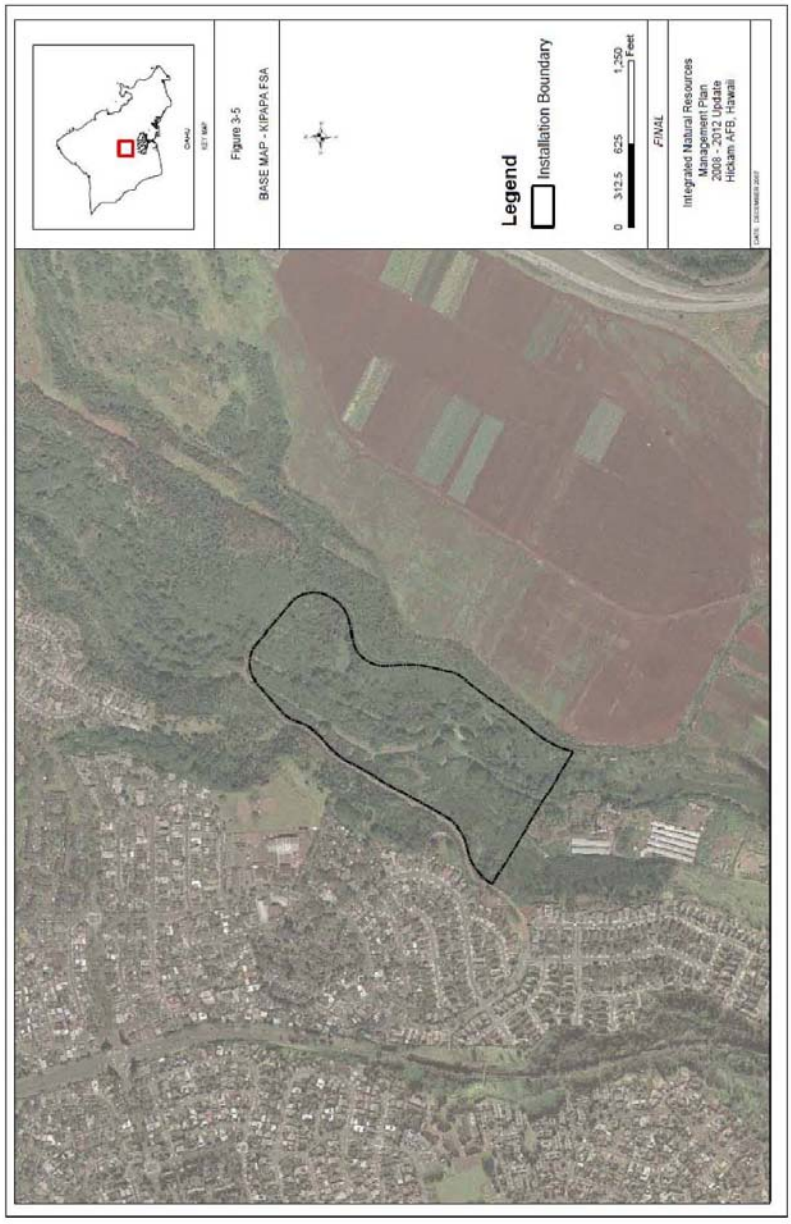
Kipapa FSA is situated at the bottom of a steep-walled gulch through which Kipapa Stream flows in a more or less southerly direction. Immediately upstream of Kipapa FSA is land managed by the Army, which was previously used for ammunition storage. Downstream of the facility is a privately owned chicken farm. There is a residential area on the west side and pineapple farms on the east side on the land above the gulch. Kipapa FSA is located between two major highways, with the Kamehameha Highway (State Route 99) crossing Kipapa Gulch approximately 0.25 miles downstream from the facility and Interstate H2 crossing the gulch about 1.5 miles upstream from the facility and passing parallel to the gulch about 0.7 miles to the east.

Wahiawa State Freshwater Park and the Wahiawa Reservoir are about 2 miles north of the FSA. The Ewa Forest Reserve is about 5 miles east of the FSA, with Kipapa Stream running from the Forest Reserve through the FSA.

3.3.5.2 Waikakalaua FSA

Waikakalaua FSA is surrounded by unimproved forests and shrub lands in Waikele Gulch and by pineapple fields and pasture. A horse stable is located about 0.25 miles northeast of the facility. Wheeler AAF lies to the north of Waikakalaua FSA, with the main airfield area about 1 mile away. The Kamehameha Highway (State Route 99) passes about 0.7 miles to the east of the facility.

Wahiawa State Freshwater Park and the Wahiawa Reservoir are about 2 miles north of the FSA. The Ewa Forest Reserve is about 5 miles east of the FSA, with Waikakalaua Stream running from the Forest Reserve past the FSA. Waikele Stream runs almost adjacent to the Waikakalaua FSA, and Melemanu Park is just northeast of the Waikakalaua FSA, near where Waikele and Waikakalaua streams meet.



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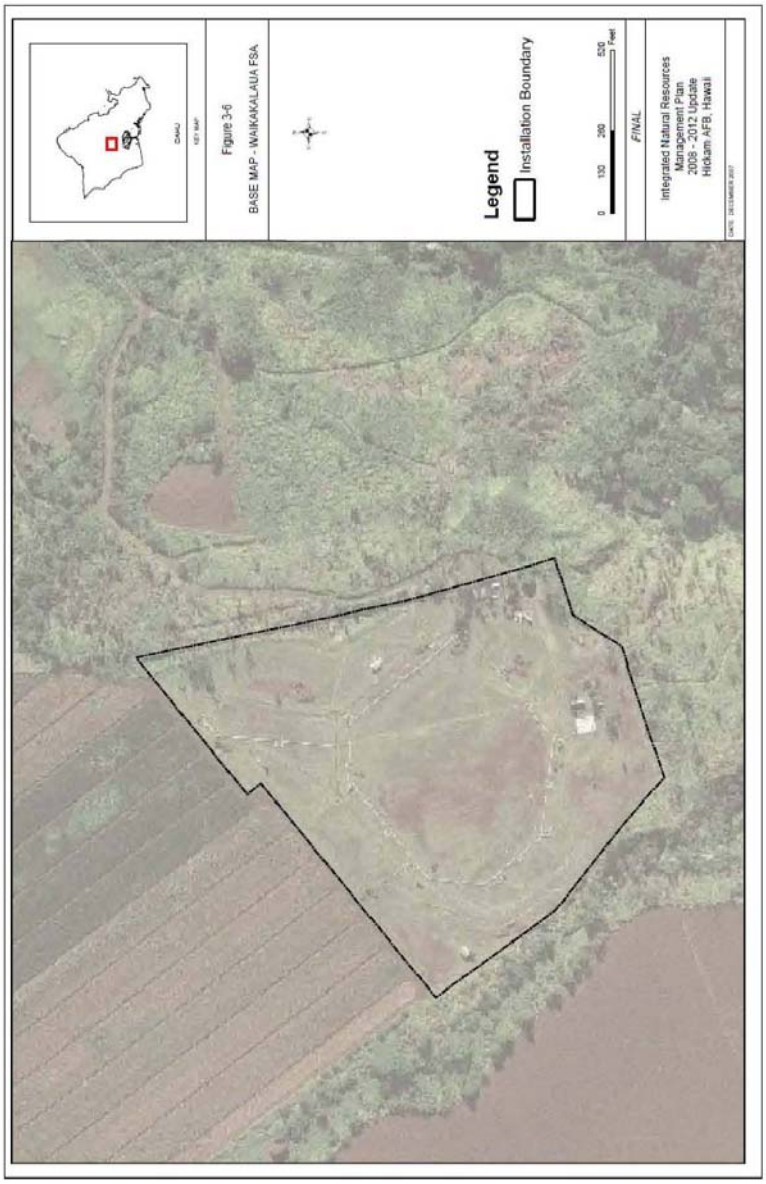

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5.1 HICKAM AFB

Hickam AFB sits on approximately 2,520 acres (Moreira 2006) of flat coastal plain located on the Leeward side of the Koolau Range, immediately west of Honolulu on the island of Oahu. This is an area with relatively low rainfall and stable temperatures. Much of the land area has been created by filling shallow coastal and low-lying sites. Native soils, influenced by marine elements, are poor substrate for most vegetation. The intensively landscaped grounds at Hickam AFB have required soil amendments and depend upon regular maintenance.

5.1.1 Climate

The climate at Hickam AFB is mild and consistent throughout the year. The average annual precipitation at Hickam AFB is about 22 inches. The greatest average monthly precipitation occurs in December and the lowest in June. The average daily temperature ranges between 72 and 81° F.

5.1.2 Topography

Hickam AFB is situated on the Pearl Harbor coastal plain on the southern coast of Oahu. This is the largest flat expanse of land on Oahu, with elevations ranging from 0 to 20 feet mean sea level (msl). The base is located just above msl, and is relatively flat throughout (see Figure 5-1 for topography).

5.1.3 Geology and Soils

The coastal plain is the culmination of a succession of marine sedimentary and terrestrial alluvial layers that were deposited over long periods with fluctuating sea levels. The emergent reef represents a present-day period of lower sea level. A wedge of sediments, known as caprock, containing strata of alluvium, lagunal muds, beach sands, volcanic tuff, and corals confines a basal aquifer. At depth these strata overlie bedrock of the Honolulu volcanic series.

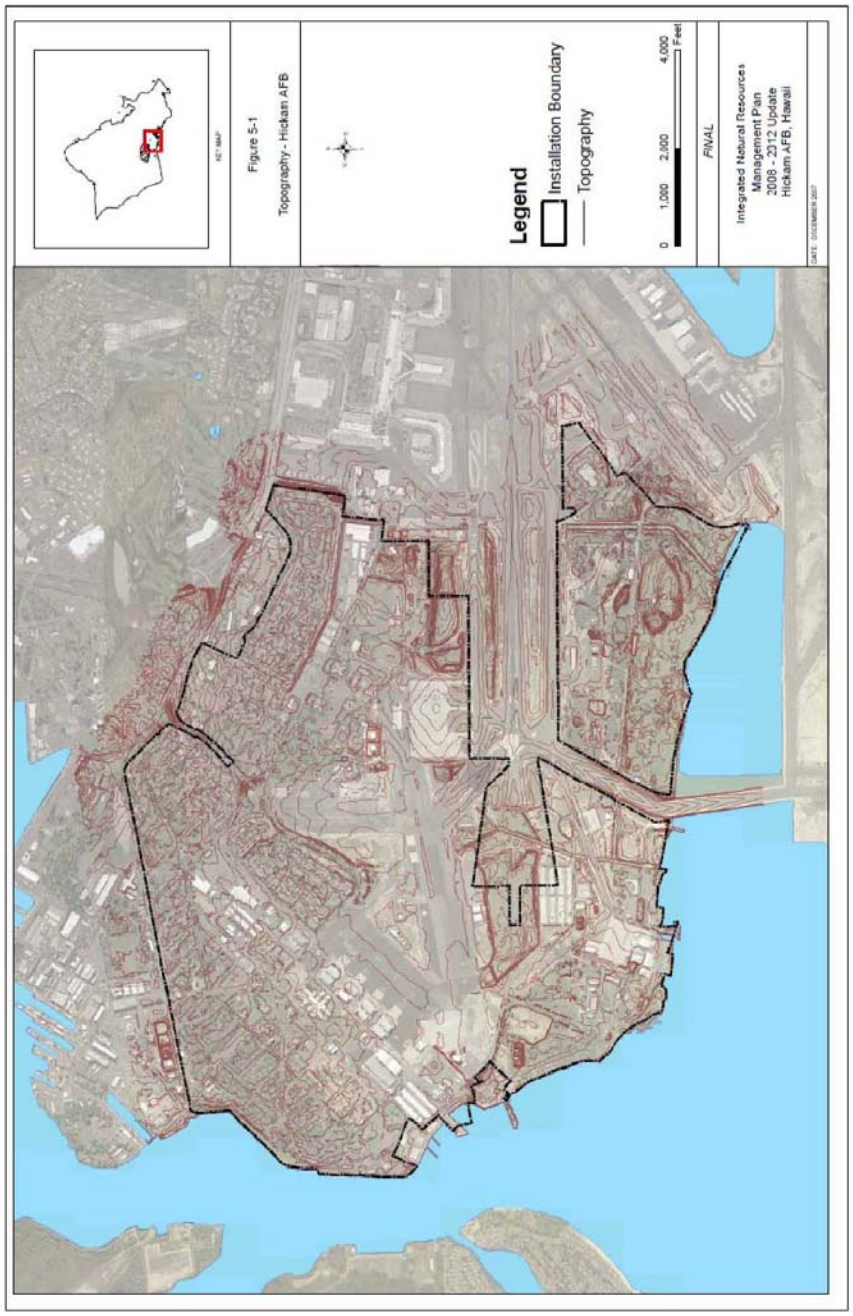
Soils on Hickam AFB are varied. Most of the land area has soils mapped as fill land (1,910 acres) which are areas filled with material dredged from the ocean or hauled in from elsewhere. The remaining five soil types on the base are related to the coastal plain setting and coral reef substratum over which the base lies. These soils are Mamala stony silty clay loam, 0-12 percent slopes; Makalapa clay, 2-6 percent slopes; Keaau stony clay, 2-6 percent slopes; Jaucus sand, 0-15 percent slopes; and coral outcrop.

The soils on Hickam AFB are generally of low value for growing vegetation, and they limit the diversity of the unmaintained flora. Most high maintenance landscaping is done on topsoil fill from off-base sources. The erosion potential for non-fill soil types found on base is generally slight to moderate, with the exception of Jaucus sand, which has high erosion potential in barren areas lacking vegetation cover. Runoff ranges from very slow to medium in these soil types.

5.1.4 Hydrology

There are no natural stream channels on Hickam AFB, but several manmade canals and numerous underground storm drains convey storm water from the base to Mamala Bay. It is believed that none of the canals have perennial water sources other than groundwater seepage. No long-term gauging records for the any of the canals on the base are known to exist, and consequently no

flood frequency information was identified for any of the watercourses. Due to their proximity to the coast and the low topographic elevation of the base, the canals are significantly influenced by tidal conditions and have relatively flat



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slopes.

Manuwai Canal, the largest watercourse on the base, follows the boundary between the base and Honolulu International Airport on the eastern edge of the installation. It provides drainage to roughly the eastern third of the base through a series of open canals and culverts, and it also receives a portion of the runoff from Honolulu International Airport. The watercourse passes beneath the main runway of the airport through a culvert. A large number of drainage swales and underground storm drains are tributary to the canal along its length. The canal empties into the Reef Runway Lagoon, which is connected to Mamala Bay.

Kumumau'u Canal is an open watercourse throughout its length and is connected to numerous drainage swales and underground storm drains. The drainage area of the canal is entirely contained within the base boundaries, draining roughly the middle third of its area.

A small portion of the western third of the base is drained by the Motor Pool Canal. Like the other base canals, it is fed by drainage swales and underground storm drain systems. The remainder of the western third of the base is drained by underground storm drains that flow directly into Mamala Bay or Pearl Harbor.

There is no watershed map for Hickam AFB because the base is a flat area that drains impervious surfaces. Given the absence of natural streams, delineation of a watershed is not relevant.

5.1.5 Land Use

AFI 32-7064 specifies three categories of natural resources management units. These successively more specific levels are grounds categories, land use categories, and land management units.

- Grounds categories follow the traditional divisions of improved, semi-improved, and unimproved land. Grounds categories are generally determined by the intensity of grounds maintenance required for their upkeep. At Hickam AFB the improved lands are those that require intensive maintenance, irrigation, and landscaping. Semi-improved grounds are those that require infrequent or unscheduled mowing and maintenance, and little or no irrigation. Unimproved grounds do not require any maintenance except occasional brush control. Grounds are discussed in greater detail in Section 6.1.1.
- Land use categories are subunits of each grounds category. Land uses are defined by the economic and social uses of the area, as opposed to the intensity of vegetation maintenance. The 12 land use categories presented in Table 5.1-1 are defined in the Hickam AFB Comprehensive Plan and summarized in Section 9.1.2 of this INRMP. Often the same land use category appears in more than one grounds category. For example, some Light Industrial areas are managed as improved grounds, and others are managed as semi-improved grounds, depending on their location on the base. Similarly, some Open Space areas are managed as semi-improved and others are unimproved, depending on their function and location.

- Land management units are a further division of the grounds and land use categories. The land management units utilized in this INRMP, categorized as Management Emphasis Areas (MEAs), are the operable units for managing the natural resources on Hickam AFB. MEAs are described in Chapter 9 of this Plan.

TABLE 5.1-1 LAND USE CLASSIFICATION FOR HICKAM AFB

Grounds Categories*	Land Use Categories	Description
I	Housing (Accompanied)	Family dwellings, playgrounds
I	Housing (Unaccompanied)	Apartments, temporary housing (TLF's)
I	Community (Service)	Schools, day care, pool, recreation centers, bowling alley, chapel, library, post office
I	Community (Commercial)	Base exchange, shopette, gas stations, theater, officers and enlisted clubs, restaurants
I	Medical	Clinics, hospitals, veterinarian
I	Administrative	Offices, engineering, MAJCOM
I, SI	Outdoor Recreation	Playgrounds, parks, ball fields, open lawns, parade grounds, golf courses, picnic areas, beaches
I, SI, UI	Open Space/ Roads	Roads and boulevards in landscaped areas of base; road right-of-ways in remote areas off base; unimproved parks, shrublands, fields, forests, and wetlands
SI	Light Industrial	Motor pool, POL, supply depot, wastewater plant, ammunition storage, warehouses, antennas
SI	Aircraft Operations and Maintenance	Hangars, maintenance shops, AGE storage and maintenance, hush house, electronics shops, fire fighting
SI	Airfield	Runways and buffer zones
UI	Open Water	Wetlands, riparian zones, ditches and ponds
* I = Improved, SI = Semi-improved, UI = Unimproved		

Hickam AFB is considered a showcase installation by the Air Force, serving as the Headquarters for PACAF and hosting many VIP, military, and other government personnel. The base is a major destination for most military personnel stationed around the Pacific Ocean and is referred to as the "Bridge Across the Pacific." Its historical role during World War II also draws visitors. For these reasons, a high priority is placed on maintenance of the improved and semi-improved grounds. Because Hickam AFB is located in the tropical climate of Hawaii, a wide variety of showy, flowering ornamental species can

thrive. The landscape architects that designed the plantings at the base have created a colorful, densely vegetated, and lush landscape in many areas of the base, using over 300 species of plants. Some of the original ornamental plantings that were installed shortly after the base was built have historical significance and are actively preserved.

5.3 HICKAM POL PIPELINE

The Kipapa and Waikakalaua FSAs are part of the Hickam POL Pipeline system, which extends from the Schofield Plateau in central Oahu, between the Waianae and Koolau mountain ranges, to the coastal plain of southern Oahu. Both FSAs are relatively small installations, occupying about 121.26 acres at Kipapa and 28.2 acres at Waikakalaua (Goo 1997, 2002).

Kipapa FSA is located approximately 3 miles southeast of Wheeler AAF at an elevation of 400 feet msl. It is situated at the bottom of a steep walled gulch through which Kipapa Stream flows in a more or less southerly direction. Immediately upstream of Kipapa FSA is land managed by the Army, which was previously used for ammunition storage. Downstream of the installation is a privately owned chicken farm. There is a residential area on the west side and pineapple farms on the east side on the terrain above the gulch.

Waikakalaua FSA is located approximately a mile south of Wheeler AAF at an elevation 720 feet msl. Pineapple fields dominate the landscape to the west of the installation, while unimproved forests, shrublands in Waikele Gulch, and pasture surround the remainder of the installation.

5.3.1 Climate

No specific climate records are available for either the Kipapa or Waikakalaua FSA locations. Consequently the available precipitation and temperature records are from the climate station nearest to the FSAs. However, given the extremely high spatial variability of precipitation in Hawaii, the available information may not be representative of the actual precipitation at the FSAs. Nevertheless, the available information suggests average annual precipitation at the FSAs is about 47 inches, the greatest average monthly precipitation occurring in January and the lowest in June. The average daily temperature ranges between about 68 and 77° F.

5.3.2 Topography

In the vicinity of the Kipapa FSA, Kipapa Gulch is approximately 160 feet deep and 500 feet wide. The FSA extends across most of the floor of the gulch. The terrain within the installation fence line is relatively level. A low, heavily vegetated berm is located along most of the eastern fence line and then terrain drops down steeply to Kipapa Stream.

Waikakalaua FSA lies on the gently sloping plain of the central Schofield Plateau. The terrain falls off sharply from the western side into a small gulch and from the southern and eastern sides into Waikele Gulch. Within the boundaries of the installation, the terrain is relatively even.

5.3.3 Geology and Soils

The Kipapa and Waikakalaua FSAs are situated in an area known as the Soils Schofield Plateau. This landform is underlain by alluvial material that has eroded from the Waianae and Koolau ranges and been deposited on the broad plain between the mountains.

Kipapa FSA has three soil types: Haleiwa silty clay, 0-2 percent slopes; Helemano silty clay, 30-90 percent slopes; and Manana silty clay, 15-25 percent slopes. The Haleiwa silty clay soil type is suitable for cultivation.

Waikakalaua FSA has two soil types: Wahiawa silty clays, 0-3 percent slopes, and Helemano silty clay, 30-90 percent slopes. The Wahiawa silty clay covers most of the installation (93 percent), and it would be suitable for cultivation except for the presence of hazardous materials resulting from past spills. Cleanup of these soils is part of the Installation Restoration Program (IRP) for this installation.

5.3.4 Hydrology

There are no watercourses on the Waikakalaua FSA. At Kipapa FSA, as indicated previously, Kipapa Stream is located within the installation boundary but to the east of the fence line surrounding the structures. There is also a small irrigation ditch on the eastern edge of the installation boundary. Surface hydrography is shown on Figure 5-4.

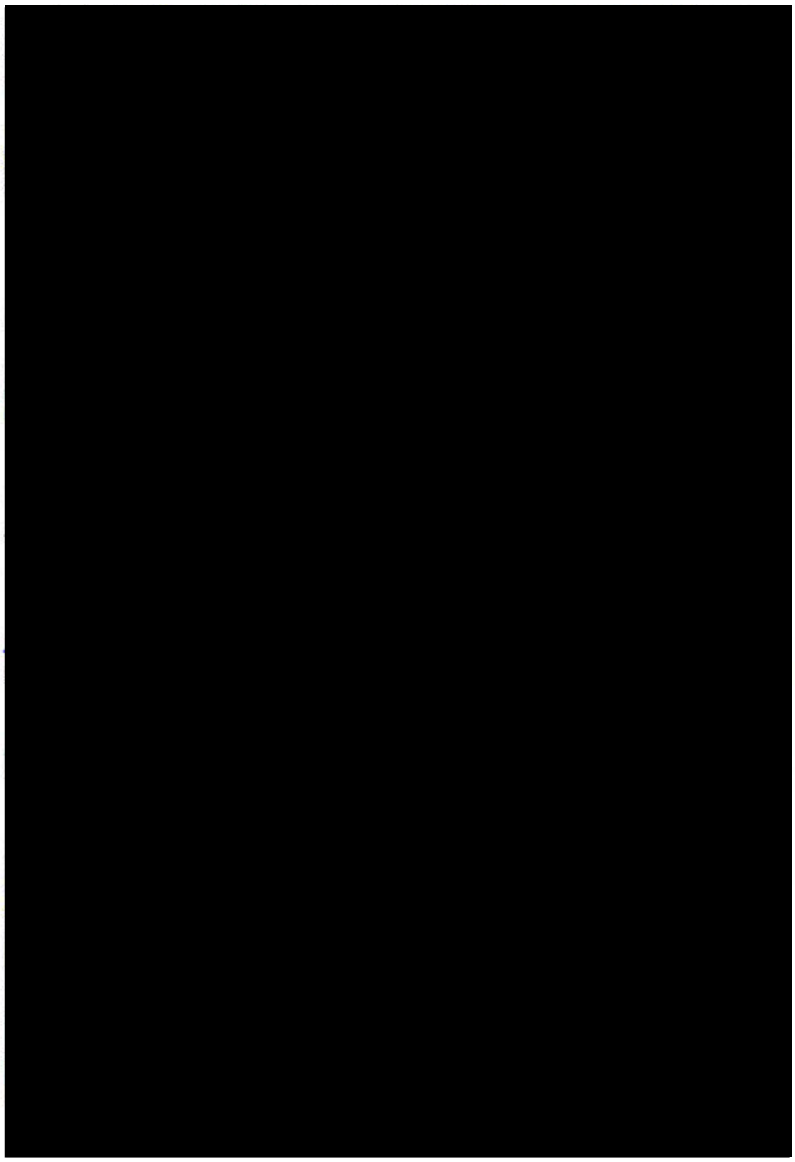
5.3.5 Land Use

The land use classification system was previously described for Hickam AFB (Section 5.1.5). Lands at Kipapa and Waikakalaua FSAs are all categorized as either Light Industrial (semi-improved) or Open Space (unimproved; Table 5.3-1).

TABLE 5.3-1 LAND USE CLASSIFICATION CATEGORIES FOR KIPAPA AND WAIKAKALAUA FSAs

Grounds Categories*	Land Use Categories	Description
Kipapa FSA		
SI	Light Industrial	Fuel tanks and ancillary buildings
UI	Open Space	Unimproved forests and shrublands on installation
Waikakalaua FSA		
SI	Light Industrial	Fuel tanks and ancillary buildings

* I = Improved, SI = Semi-improved, UI = Unimproved



Redaction:Defense Critical Security Information Statute 10 U.S.C. § 130e

TABLE 6-1 FEDERALLY LISTED ANIMAL SPECIES OBSERVED OR POTENTIALLY OCCURRING AT HICKAM and HICKAM POL PIPELINE

Species	Status	Observed	Potentially Occurring	Breeding and Nesting Seasons
Hawaiian hoary bat ope'ape'a	E		X	Fall mating followed by delayed fertilization – young born May through June
Hawaiian monk seal, 'ilio-holo-I-ka-uaua	E	X		Pupping may occur throughout the year but most births occurs between February and August
Hawaiian coot, 'alae ke'oke'o	E		X	Nesting occurs from March to September
Common moorhen, 'alae 'ula	E		X	May nest year-round but most activity occurs March to August.
Hawaiian short-eared owl, pueo	E (STATE ONLY)	X		May breed throughout the year
Hawaiian duck, koloa maoli	E		X	Nesting occurs from December through May
Black-necked stilt, ae'o	E	X		Nests March through August with peaks in May and June
Green sea turtle, honu	E	X		Nesting occurs late April through September with peak activity in June and July

Federal Status: E = Endangered; T = Threatened; C = Candidate for Listing; SOC = Species of Concern (USFWS 1996)

Sources: See Appendix D

6.1 HICKAM AFB

Located at the mouth of Pearl Harbor, approximately one-half of the base perimeter of Hickam AFB is adjoined by salt water; the other half by Honolulu International Airport, various civilian and military highways, commercial zones, and the Pearl Harbor Naval Reservation. Most of the base is developed, although some areas in the southern portion of the base are occupied by relatively unmanaged vegetation. Immediately offshore of Hickam AFB to the south is a broad, shallow reef system, within which a runway (known as the Reef Runway) has been constructed. Much of the base is landscaped, particularly around the central administration and residential areas.

6.1.1 Vegetation

Hickam AFB has been disturbed throughout and has no natural vegetation. The primary processes controlling vegetation on the base are salinity, moisture levels, and frequency of disturbance (EA 1996a). In the southern portion of the base, extending inland from the coastline for at least 1,500 feet in places, a shallow, brackish groundwater table results in wet, saline soils favoring pickleweed ('akulikuli, Batis maritima). In areas along the marine shoreline or along the edges of canals, shallow brackish water is favorable habitat for mangroves. Farther from the shoreline, or where the water table is lower, the well-drained coral line substrate results in droughty conditions. Following disturbance in these drier areas, ruderal species become established,

Exotic plants (and animals) are those that are not native to Hawaii

developing eventually into open stands of shrubby kiawe (Prosopis pallida). Left undisturbed, these open kiawe stands form closed-canopy forests that reach 30 or 40 feet in height. If regularly mowed, the kiawe is suppressed, and the vegetation remains dominated by herbaceous, ruderal species.

6.1.1.1 Regional and Historic Natural Vegetation

There are no naturally occurring, native plant communities in the vicinity of Hickam AFB. Much of the base was constructed on a filled area that had previously been coral reef, so the lower-elevation areas of the base had no historic vegetation.

6.1.1.2 Existing Native Vegetation Cover Types

There are no naturally occurring, native plant communities on Hickam AFB. Native plant species are occasionally used in landscaping projects, but no native communities have been created on the base. These non-native species are often referred to as exotic species in this INRMP.

6.1.1.3 Existing Non-Native Vegetation Cover Types

Hickam AFB is largely developed and has relatively little unmanaged vegetation. Most of the vegetation cover is in landscaped areas, including extensive turf that is mowed regularly. The managed, landscaped areas occur mostly around buildings, main roads, and recreational areas. Extensive areas of herbaceous ruderal vegetation that occur in the airfield area are periodically maintained. Unmanaged vegetation is mostly found in the southern portion of the base and includes buffelgrass/kiawe woodland, kiawe forest, pickleweed flats, and mangrove (Table 6.1-1).

TABLE 6.1-1 AREA OF VEGETATION COVER TYPES ON HICKAM AFB

Cover Type	Acres
Buffelgrass-kiawe woodland	27.8
Kiawe forest	123.2
Pickleweed flats	18.2
Mangrove	14.1
Herbaceous ruderal	344.4
Landscaped area	1039.6
All types	1567.3

Unmanaged Vegetation

Buffelgrass/Kiawe Woodland--- This vegetation type is characterized by a dense cover of buffelgrass (*Cenchrus ciliaris*), 1-2 feet tall, with a few scattered kiawe trees, 10-15 feet tall. Tree canopy cover is 10 percent or less, and shrubs are uncommon. The buffelgrass forms an almost monotypic cover, and there are few other grass and herbaceous species in these areas. Buffelgrass/kiawe woodland is located on the elevated areas near the playing fields in the northeastern corner of the base.

Kiawe Forest--- Kiawe forest occurs in a variety of locations, with extensive areas of forest just north of the Hickam AFB Golf Course and other large

patches near Fort Kamehameha. This vegetation type consists of groves of younger kiawe trees 10-20 feet high or in some areas older, mature kiawe trees, 20-30 feet tall. Where the canopy is open (30-50 percent cover), koa-haole (*Leucana leucocephala*) shrubs often form a subcanopy layer. In places where the canopy is somewhat open, there is generally more herbaceous ground cover, which includes species such as green panicgrass (*Panicum maximum var. trichoglume*), Chinese violet (*Asystasia gangetica*), swollen fingergrass (ma'u lei, *Chloris barbata*), golden crown-beard (*Verbesina encelioides*), buffelgrass, and slender mimosa (*Desmanthus virgatus*).

Pickleweed Flats--- This vegetation type is characterized by monotypic stands of pickleweed, a somewhat succulent salt-tolerant plant species. This cover type is not common on the base; it occurs primarily in low-lying areas where the brackish water table is close to the surface. There are two patches just north of the meteorological station near the Fort Kamehameha chapel, a large area west of Seaman Avenue, one patch in the wetland reserve area southeast of Fort Kamehameha, one patch in the Prime BEEF training area, and a small patch at the mouth of Manuwai Canal.

Mangrove--- American, or red, mangrove (*Rhizophora mangle*) forms dense thickets in the canals and drainage ditches that are not maintained and in mud flats and shallow waters along the shoreline, especially in the wetland management area. Along the main drainage ways, such as the Manuwai Canal, the mangrove has been cut back, but there is some resprouting of the plants, especially those closer to the canal banks. Common associates of the mangrove wetland are Indian pluchea shrubs (*Pluchea indica*), milo trees (*Thespesia populnea*), and succulent mats of pickleweed.

Managed Vegetation

Managed vegetation or turf is shown in Figure 6-1A and consists of herbaceous ruderal vegetation and other landscaped areas. The turf map represents the areas of managed grounds that are predominantly or exclusively covered with grass. These include the median strips between roads and airfield runways, golf courses, housing lawns, athletic fields, and other open fields or groves of trees not categorized as unmanaged vegetation. Turf areas are divided also into low and high maintenance categories based on the frequency of landscape practices. Landscape-low maintenance areas are mowed, watered, or otherwise maintained less frequently than once a week. Landscaped-high maintenance areas are mowed, watered, or otherwise maintained a minimum of once a week.

Herbaceous, Ruderal Vegetation--- Included in the extensive turf areas around the runways and along roadways are areas that are regularly mowed and are dominated by grasses and a diversity of ruderal herbaceous plant species. Ruderal plants are those that tend to become established after disturbance and are often annual or biennial in life history. Because they are actively managed, areas of herbaceous, ruderal vegetation are considered landscaped areas, even though they have a diversity of species that have largely established on their own, and consequently have some characteristics of an unmanaged vegetation cover type. In these areas buffelgrass is the most common plant species. Other plants observed in these recently disturbed areas included flaveria (*Flaveria trinervia*), Heliotropium procumbens, swollen

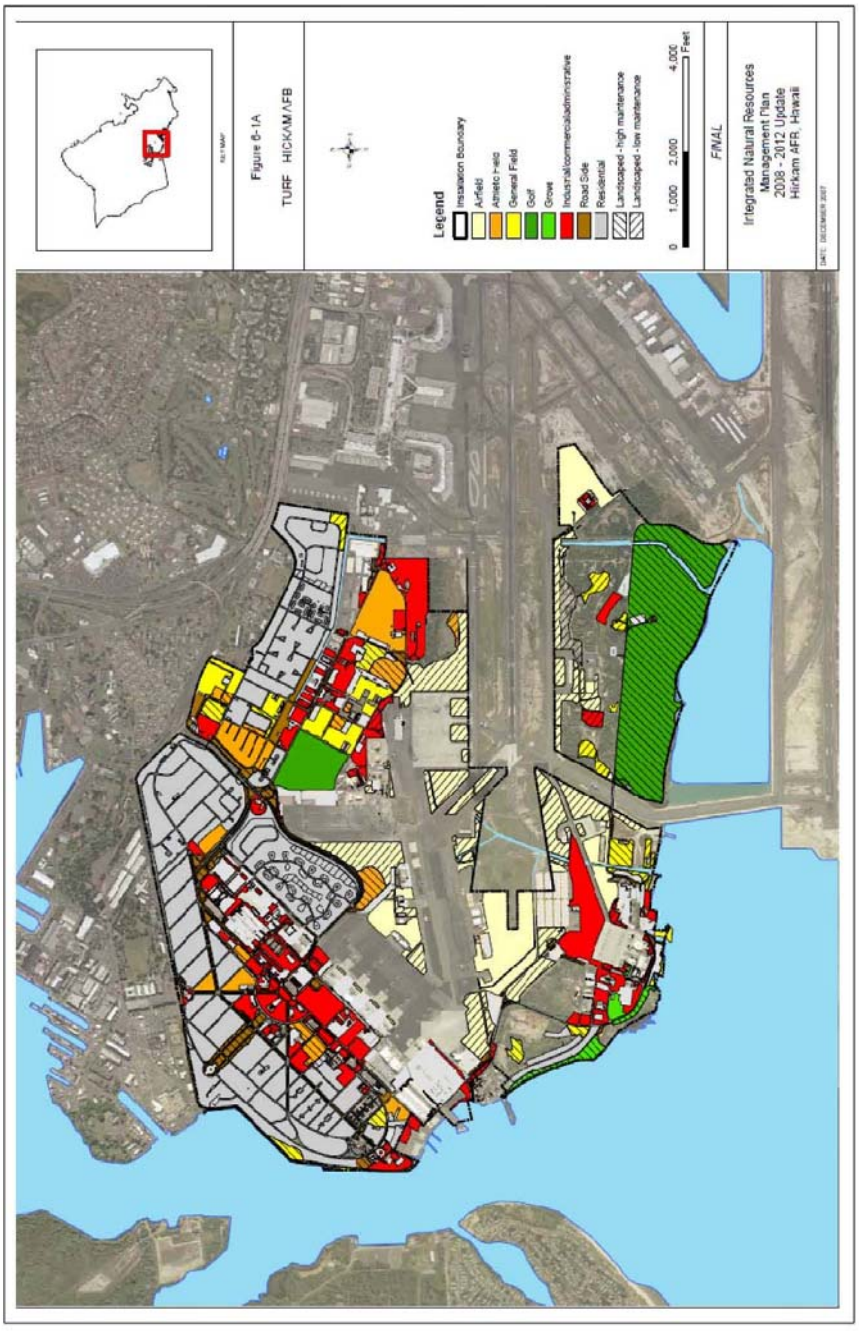
fingergrass, pitted beardgrass (*Bothriochloa pertusa*), hairy spurge (*Chamaesyce hirta*), white-flowered bidens (*Bidens alba var. radiata*), coatbuttons (*Tridax procumbens*), and Australian saltbush (*Atriplex semibaccata*).

Other Landscaped Areas--- Landscaped areas at Hickam AFB include abundant and diverse plantings of ornamental shrubs and trees. Extensive areas of turf grass were planted to create recreational fields, parks, and walking and gathering areas. Maintained lawns are located along most roadsides, among the administrative and community support buildings, in residential areas, around the runways, on golf courses, near monuments, and on playing fields. The most commonly used grass species in these areas is Bermuda grass (manienie, *Cynodon dactylon*). The acreage estimate is all of the turf areas (from Figure 6-1A) minus the herbaceous, ruderal vegetation.

Plantings of ornamental shrubs and trees on Hickam AFB are diverse and abundant, especially in the residential, administrative, and community support areas. In residential neighborhoods the more commonly planted trees include plumeria (Plumeria acuminata), paperbark (Melaleuca leucadendron), Benjamin tree (Ficus benjamina), true kamani (Calophyllum inophyllum), banana (maia, Musa paradisiaca), and sea grape (Coccoloba uvifera). The common palm trees in these areas include areca palm (Chrysalidocarpus lutescens) and coco palm (niu, Cocos nucifera). The most common trees observed around the administrative buildings and the central shopping area are yellow poinciana (Peltophorum pterocarpum), paperbark, royal palm (Roystonea regia), red palm (Dictyosperma album), and Singapore plumeria (Plumeria obtusa). The two golf courses at Hickam AFB are also highly landscaped areas, which include ornamental species such as monkeypod ('ohai, Samanea saman), royal palm, coco palm, bottle palm (Mascarena lagenicaulis), kiawe, and Norfolk pine (Araucaria heterophylla).

Tree Cover--- There are almost 300 non-native tree, brush, and vine species listed in the 1990 General Landscape Development Plan (GLDP) maps at Hickam Air Force Base. These are not included in the plant list in Appendix C. Numbers which follow plant names in the sections below refer to their placement on the GLDP species list. The GLDP maps and 1996 aerial orthophoto were used to determine and map tree species in the landscaped and outdoor recreation areas for Figure 6-1B, Tree Cover. Tree cover is divided into two primary categories-street trees and community trees. Street trees are further divided into streets with center islands and streets without. For the community trees, the largest diameter tree is identified as predominant, and the amount of cover provided is identified.

Listed below are the main tree groups for all the categories. The tree numbers correspond to the GLDP species numbers. A brief description of the predominant species is included.



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Street Trees - Streets with Center Islands

Monkeypod with Date Palm--- Monkeypod ('ohai, *Samanea saman*) 1 line each side of the boulevard, with date palm on the island. Date palm may include numbers 33 and 106 (*Phoenix dactylifera and Phoenix canariensis*). Streets include Signer Boulevard, Fox Boulevard, and Vandenburg Boulevard (partial). Monkeypod are large-canopied trees which bloom in the spring and summer. They have fernlike leaves which drop in February and March. The date palm are ancient trees with clusters of edible fruits, borne over many years. They require very little water and may produce up to 300 pounds of dates per tree (Hargreaves 1964).

Royal Poinciana with Palms--- Royal poinciana ('ohai, *'ula, Delonix regia*) 4 are on either side of the boulevard, with California fan palm (*Washingtonia filifera*) 53, royal palm 29, or date palm (*Phoenix dactylifera*) 106 on the island. Streets include Boquet Boulevard, Mills Boulevard, and Vandenburg Boulevard (partial). Royal poinciana is extremely striking, with dense clusters of scarlet blossoms which bloom from early spring through late summer. It has fern-like leaves with long brown pods, the seeds of which are often strung into leis (Hargreaves 1964).

Royal Palm with Benjamin Trees--- Royal palm 29 are on the street side, with Benjamin trees 24 on the inside. Streets include Eighth and Ninth. The predominant trees are the Benjamin trees, which are set back from the street. These trees are members of the Ficus genus and are large canopied with aerial roots which grow earthward from horizontal branches. The royal palm are a native of Cuba and were first introduced to Hawaii in 1850. The trees are smooth ringed and light gray and can reach heights of 60 feet (Hargreaves 1964).

Banyan with Date Palms---- Banyan (*Ficus spp.*) 101 line either side of the boulevard, with date palm (*Phoenix dactylifera*) 106 on the island. Streets include O'Malley Boulevard. There are over 800 species of Ficus in the world. These large-canopied trees have aerial roots which grow earthward from horizontal branches (Hargreaves 1964).

Street Trees - Streets without Center Islands

Monkeypod--- Monkeypod ('ohai, *Samanea saman*) 1 may include Norfolk pine (*Araucaria heterophylla*) 40. Streets include Sixth, Tenth, and Beard Avenue.

Shower Trees---This group may include pink and white shower (*Cassia javanica*) 37, yellow shower (*Cassia fistula*) 37Y, or rainbow shower (*Cassia javanica x.c. fistula*) 77. Streets include Second (partial), Fifth, Seventh, Thirteenth, Fourteenth, and Cornet Avenue. There are several shower tree species in Hawaii, which have been cultivated since 1870. They bloom from the end of March until May and have pods that contain seeds which are often used in leis (Hargreaves 1964).

Mahogany--- Mahogany (*Swietenia mahagoni*) 6 may include kou (*Cordia subcordata*) 13, paperbark (*Melaleuca leucadendron*) 12, scattered monkeypod ('ohai, *Samanea saman*) 1, pink and white shower (*Cassia javanica*) 37, or yellow shower (*Cassia fistula*) 37Y. Streets include Second

(partial), Fourth, Twelfth, Nineteenth (partial), and the Nimitz Highway at the corner with Porter Avenue. Mahogany is an evergreen with dark red wood. Native to the Florida Keys and the West Indies, these trees grow to 75 feet and have shiny dark leaves of 4-8 inches. Their woody fruit is 2-4 inches long and stands erect on curved stems on the branches (Hargreaves 1964).

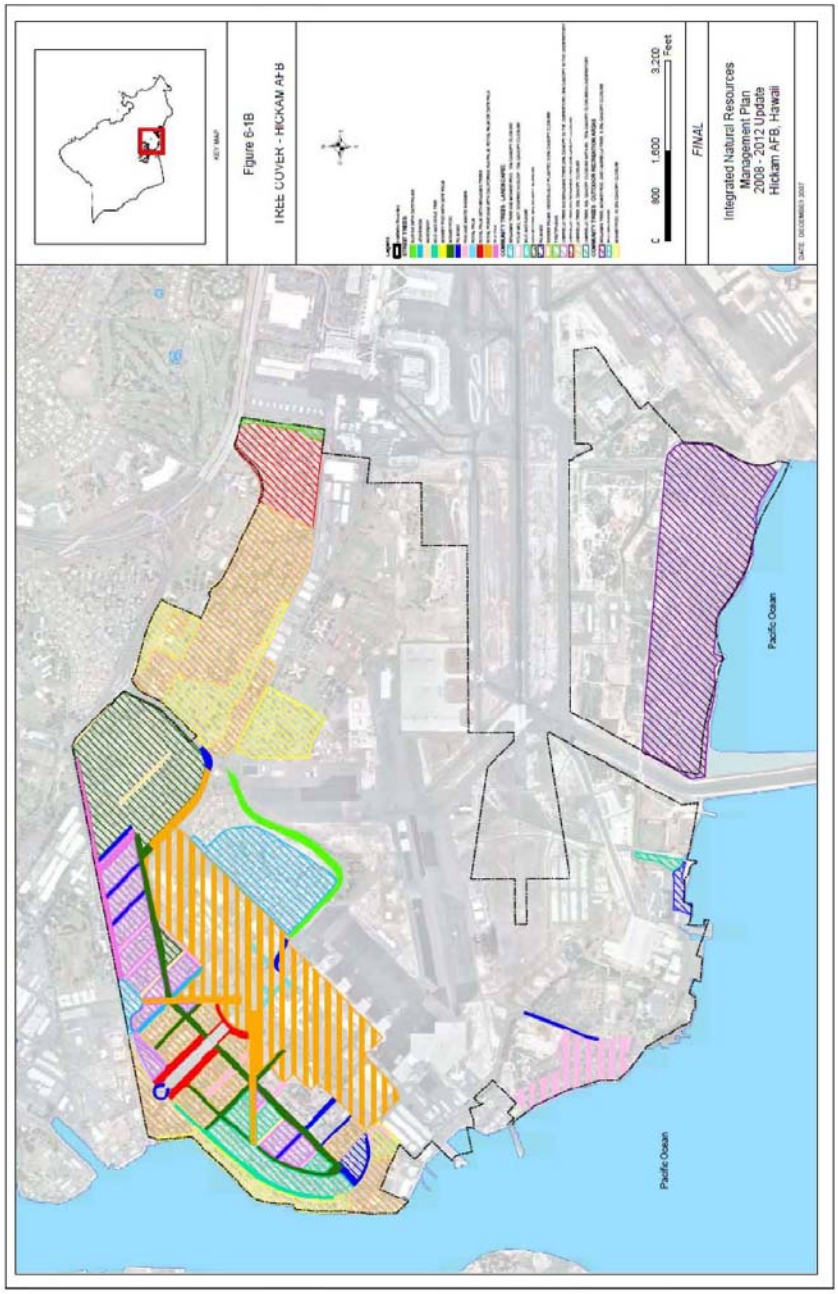
Jacaranda--- Jacaranda (*Jacaranda acutifolia*) 108 are native of Brazil and have gray bark, feathery leaves, and blue blossoms. They bloom from January through June, and when the blossoms fall, they carpet the ground with violet-blue color (Hargreaves 1964). Streets include Eleventh.

Silk Oak---Silk oak ('oka kilika, Grevillea robusta) 71 may include kou (Cordia subcordata) 13, or plumeria (Plumeria acuminata) 7. Streets include Seventeenth and Porter Avenue. Porter Avenue from Owens to Seventeenth has kou only on the south side; from Seventeenth to the end, kou is on the north side only. Silk oak is one of the most common reforesting trees in Hawaii, with the seeds germinating easily. It is a native of Australia and was introduced in 1880. Over 2 million silk oaks were planted in Hawaii for timber between 1919 and 1959 (Merlin 1995). The species has fern-like leaves with dark leaflets. The silk oak blooms from early spring until fall and has dark yellow feathery blooms. The tree is fast growing and can reach 100 feet tall. The kou is an evergreen tree from tropical America and flowers almost continuously. The kou thrives near the sea and requires little water. It has tubular flowers about 1 inch long with 1-inch-round edible fruit. The leaves are 3-8 inches long, and parts of the tree are used medicinally (Hargreaves 1964).

Milo and Gold Tree--- Milo (*Thespesia populnea*) 14 and gold tree (*Tabebuia donnell smithiv*) 15 may include coco palm (niu, *Cocos nucifera*) 30 or red palm (*Dictyosperma album*) 31. Streets include Julian Avenue. The gold tree is one of the strongest and largest of tropical trees, with highly valuable wood. The wood is extremely durable, and a single cubic foot may weigh from 60 to 80 pounds (Hargreaves 1964).

Palm Mix---This group is predominantly coco palm (niu, *Cocos nucifera*) 30, with fiji fan palm (*Pritchardia pacifica*) 50, loulu palm (*Pritchardia spp.*) 52, areca palm (*Chrysalidocarpus lutescens*) 27, blue latan palm (*Latania loddigesb*) 34, and sago palm (*Cycas revoluta*) 75. The group may include kou (*Cordia subcordata*) 13, mahogany (*Swietenia managoni*) 6, Norfolk pine (*Araucaria heterophylla*) 40, kukui (*Aleurites moluccana*) 20, kassod tree (*Cassia siamea*) 126, umbrella tree (*Brassaia actinophylla*) 23, or avocado (*Persea americana*) 72. Streets include the areas near First, Third, Fifteenth, Sixteenth, Eighteenth, Manzelma Circle, Vandenburg Boulevard (partial), and Seaman Avenue. The coco palm is one of the best known palms, with its cultivation dating back to prehistoric times. They can reach heights of 100 feet and bear over 40 fruit clusters yearly. Seeds can retain their germinating power for up to 4 months after floating in the ocean (Hargreaves 1964).

Royal Palm--- Royal palm (*Roystonea regia*) 29 are located below Atterbury Circle, along E Street, and along Hangar Avenue. The royal palm are native of Cuba and were first introduced to Hawaii in 1850. The trees are smooth ringed and light gray and can reach heights of 60 feet (Hargreaves 1964).



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Community Trees - Landscaped Areas

Community trees are trees in neighborhoods that are not planted in a linear pattern along major roadways. The classification system used for the community trees began with the identification of the primary tree species from the GLDP maps and 1996 aerial orthophoto. Since many of the community tree areas include the same species, an estimate of cover, or canopy closure, has been devised. This canopy closure estimate helps to identify the areas where the community trees are well established and where shade is greatest. The estimate is based on observation of the aerial orthophoto, and no field verification was used. Since the canopy closure figure is an estimate, three groupings can be interpreted as: 0-10% - sparse canopy; 11-30% - medium canopy; and >30% - dense canopy.

Benjamin Tree and Monkeypod, Sparse Canopy--- The predominant large trees are Benjamin tree (*Ficus benjamina*) 24 and monkeypod ('ohai, *Samanea saman*) 1, with jacaranda (*Jacaranda acutifolia*) 108 lining the streets. Areas include O'Malley Boulevard to Vandenburg Boulevard, with streets including Mercury Street, Gemini Avenue, and Apollo Avenue.

Monkeypod, Medium Canopy--- The predominant large tree is monkeypod ('ohai, *Samanea saman*) 1, with some umbrella tree (*Brassaia actinophylla*) 23. This group may include coco palm (niu, *Cocos nucifera*) 30, plumeria (*Plumeria acuminata*) 7, rainbow shower (*Cassia javanica x.c. fistula*) 77, and wiliwili (*Erythrina sandwicensis*) 25. Areas include Vandenburg Boulevard to Nimitz Highway.

Umbrella Tree, Medium Canopy--- The predominant large tree is umbrella tree (*Brassaia actinophylla*) 23, with scattered Benjamin tree (*Ficus benjamina*) 24, Chinese banyan (*Ficus retusa*) 19, and monkeypod ('ohai, *Samanea saman*) 1. This group may include coco palm (niu, *Cocos nucifera*) 30, areca palm (*Chrysalidocarpus lutescens*) 27, Fiji fan palm (*Pritchardia pacifica*) 50, plumeria (*Plumeria acuminata*) 7, and kou (*Cordia subcordata*) 13. Areas include Puuloa Circle to Kamila Street.

Umbrella Tree and Benjamin Tree, Medium Canopy in the Overstory, Dense Canopy in the Understory Trees and Shrubs---The predominant large trees are umbrella tree (*Brassaia actinophylla*) 23 and Benjamin tree (*Ficus benjamina*) 24, with scattered Chinese banyan (*Ficus retusa*) 19, coco palm (*Cocos nucifera*) 30, areca palm (*Chrysalidocarpus lutescens*) 27, manila palm (*Veitchia merrillin*) 28, mahogany (*Swietenia managoni*) 6, and Norfolk pine (*Araucaria heterophylla*) 40. Areas include Second Street to Fourth Street and Eleventh Street to Eighteenth Street.

Umbrella Tree and Benjamin Tree, Dense Canopy---The predominant large trees are umbrella tree (*Brassaia actinophylla*) 23 and Benjamin tree (*Ficus benjamina*) 24, with scattered Chinese banyan (*Ficus retusa*) 19, and monkeypod ('ohai, *Samanea saman*) 1. This group may include coco palm (niu, *Cocos nucifera*) 30, areca palm (*Chrysalidocarpus lutescens*) 27, plumeria (*Plumeria acuminata*) 7, Norfolk pine (*Araucaria heterophylla*) 40, mango (*Mangifera indica*) 44, and tipa (*Tipuana tipu*) 142. Areas include Kamila Street to K Avenue.

Umbrella Tree, Dense Canopy with 60-70 Percent Canopy in Understory Shrubs and Small Trees---The predominant large tree is umbrella tree

(*Brassaia actinophylla*) 23. This group may include coco palm (niu, *Cocos nucifera*) 30, thatch palm (*Thrinax parviflora*) 70, queen palm (*arecastrum romanzoffianum*) 119, dwarf date palm (*Phoenix robelinin*) 117, and Norfolk pine (*Araucaria heterophylla*) 40. Areas include Beard Avenue to Julian Avenue.

Palm Mix---This group is predominantly coco palm (*Cocos nucifera*) 30, with very scattered large trees such as monkeypod (*Samanea saman*) 1, Benjamin tree (*Ficus benjamina*) 24, and sausage tree (*Kigelia pinnata*) 38. Areas include the vicinity of First Street, Wilson Street, and Owens Street.

Sparse Palms, Individually Planted, Sparse Canopy--- The predominant tree in this area is the royal palm (*Roystonea regia*) 29 with scattered coco palm (niu, *Cocos nucifera*) 30, royal poinciana (*Delonix regia*) 4, fiji fan palm (*Pritchardia pacifica*) 50, blue latan palm (*Latania loddigesh*) 34, loulu palm (*Pritchardia spp.*) 52, and areca palm (*Chrysalidocarpus lutescens*). This area covers from A Street to Vandenburg Boulevard and from Worthington Avenue to the edge of the Aircraft Parking Apron.

Ficus Mix, Dense Canopy---This area is not covered on the GLDP, but it appears that the predominant tree is a Ficus spp. The area covered includes the managed lands of the Fort Kamehameha Historic District.

Tipal Tipuana---This group is predominantly tipa (*Tipuana tipu*) 142. Areas include the northeastern boundary of the base near Ohana Nui Circle.

Community Trees-Outdoor Recreation Areas

Milo and Kiawe---The predominant trees are milo (*Thespesia populnea*) 14 and kiawe (*Prosopis chilensis*) 39. Areas include the western side of Kumumau'u Canal near the battery. The kiawe can reach heights of 60 feet and has fern-like leaves, thorny branches, and gnarled trunks. It was introduced to Hawaii in 1828 from Paris. The kiawe is used to reforest wasteland and produce fuel, lumber, charcoal, food, medicine, tannin, and honey (from the pale yellow flowers). The wax bean-like pods contain 25 percent sugar and are used for fodder (Hargreaves 1964).

Monkeypod, Medium Canopy---The predominant large tree is monkeypod (*'ohai, Samanea saman*) 1, with some coco palm (niu, *Cocos nucifera*) 30, areca palm (*Chrysalidocarpus lutenscens*) 7, rainbow shower (*Cassia javanica x.c. fistula*) 77, and wiliwili (*Erythrina sandwicensis*) 25. Areas include the recreation land in the northern section near Mokulele School and Gardner Avenue, the 9-hole golf course, and along the coastline north of Julian Avenue.

Benjamin Tree, Monkeypod, and Umbrella Tree, Sparse Canopy---The predominant large trees are Benjamin tree (*Ficus benjamina*) 24, monkeypod ('ohia, *Samanea saman*) 1, and umbrella tree (*Brassaia actinophylla*) 23. Scattered throughout are some coco palm (niu, *Cocos nucifera*) 30 and kiawe (*Prosopis chilensis*) 39. Areas include the 18-hole golf course.

6.1.2 Aquatic Habitats and Species

Aquatic resources on Hickam AFB are found in Manuwai Canal, Kumumau'u Canal, the Motor Pool Canal, and their associated tributary canals. Hickam AFB also includes a sandy-bottomed, brackish lagoon (Reef Runway Lagoon)

of approximately 200 acres which lies between the Reef Runway and the main shoreline, and also offshore marine habitats.

6.1.2.1 Canals

Manuwai Canal, Kumumau'u Canal, and the Motor Pool Canal total 6.1 miles in length and drain to the south into Mamala Bay. All of the canals at Hickam AFB have low flows, high suspended sediment loads, and deep silt and clay substrates. The entire lengths of Manuwai and Kumumau'u Canals are channelized, and the substrates are dominated by sand and fine materials. The streams are consistently shallow, ranging from a mean of 0.6 feet in the Motor Pool Canal to 1.2 feet in Manuwai Canal (EA 1996a). Channel unit types generally consist of glides, which are calm stretches of shallow water. With the exception of the lower portion of Manuwai Canal, immediately adjacent to the golf course, the canals lack a riparian corridor and generally do not resemble natural channels. Shade and vegetative cover are rare, as much of the riparian zone contains mowed grasses, pickleweed, and young mangroves. Mangroves also grow within the channels of the canal. All vegetation is regularly cut low except in "greenbelt" areas near the canal mouths, where kiawe and milo trees are present.

Water Quality

Recent measurements suggest that water quality conditions for aquatic life are poor within both Kumumau'u and Manuwai Canals. While temperature and pH were within acceptable ranges when measured, dissolved oxygen levels were considerably below the generally accepted level of 5.0 mg/L required for diverse aquatic life (EA 1996a). Despite these low dissolved oxygen levels, these sites supported some tolerant fish species. Past measurements of surface water quality and chemistry in Kumumau'u Canal indicated detectable levels of two semivolatile and three volatile organic compounds (VOCs), 10 polynuclear aromatic hydrocarbons (PAHs), 10 pesticides, and 16 metals (EA 1994c). Samples from Manuwai Canal had detectable levels of phenols in 1988, and cadmium, silver, selenium, mercury, and lead at various times (EA 1994c).

Salinity appears to be an important factor controlling the distribution and diversity of fish in the two major canals. Salinities measured in 1996 ranged from 13.5 to 34.0 parts per thousand (ppt) at Kumumau'u Canal and 0.0 to 31.2 ppt at Manuwai Canal (EA 1996a). Salinity measurements suggest that there is a more fully developed salt wedge in Manuwai Canal than in Kumumau'u Canal, which had similar surface and bottom measurements at three of the five sampling sites.

Species Diversity

Sampling conducted in 1996 in Manuwai and Kumumau'u Canals revealed the presence of 31 species of aquatic fauna at Hickam AFB, including 20 species of fish, six crustaceans, three mollusks, and one amphibian (see Appendix D for complete species lists). Of the 31 species, seven were introduced, 10 were native freshwater/ amphidromous species, and 14 were primarily marine species utilizing brackish water as juvenile rearing areas. Eight species were common to the two canals, 10 species were found in Manuwai Canal but not in Kumumau'u, and 13 species were found in Kumumau'u Canal but not in

Manuwai Canal. Four species of fish were observed in the Reef Runway Lagoon. No obvious factors were observed that could explain the differences in species composition between the canals, particularly for the marine species. Differences in the freshwater species are likely due, in part, to differences in the unauthorized and independent introductions of fish to the canals.

Fish---Primarily marine organisms were observed during 1996 surveys in estuary mouths and in higher-salinity waters in the canals (EA 1996a). False mullet (ououa, *Neomyxus leucisus*) and striped mullet (ama'ama, *Mugil cephalus*) were common marine species observed in all three canals at Hickam AFB. Also observed were large specimens of bonefish (o'io, *Albula sp.*) and great barracuda (kaku, *Sphyraena barracuda*). The estuarine habitats at the stream mouths of canals represent an important nursery area for juvenile Hawaiian flagtail ('aholehole, *Kuhlia sandvicensis*), false mullet, striped mullet, and bonefish, all three of which are important commercial and recreational fish species in Hawaii.

The lower-salinity and freshwater reaches of all streams contained primarily introduced species, including the one observed amphibian. Several species in the family Poeciliidae (mollies, mosquitofish) are among the most widely spread of the introduced non-native freshwater fish species and are highly tolerant of degraded water quality and poor habitat conditions. These were the most commonly observed species in all of the low-salinity habitats surveyed. Tilapia (*Tilapia ssp.*) constituted the majority of the biomass of introduced fish species in all canals. They can tolerate low dissolved oxygen levels and poor water quality, and some species may even be able to spawn in marine environments. Tilapia are thought to prey on native stream organisms.

Native stream "gobies" in the families Eleotridae (o'opu akupa, *Eleotris sandwicensis*) and Gobiidae (o'opu naniha, *Stenogobius hawaiiensis*) were both present in Kumumau'u Canal, while only o'opu naniha was found in Manuwai Canal. Both were observed in relatively low numbers in brackish water. The low abundance of gobies may be related to channelization, habitat loss, and competition from introduced species.

Invertebrates---Seven endemic species of crustaceans were observed, primarily at the downstream sites with higher salinity. The blue-pincher crab (*Thalamita crenata*) was the crustacean most often observed on the base. Crayfish (*Procambrus clarkih*) were observed at the upper two sites in Manuwai Canal, but were not observed in Kumumau'u Canal. Surprisingly, mollusks were observed only in Manuwai Canal. They consisted primarily of Littorina scabra and Thiarid snails of the genus Melanoides.

6.1.2.2 Ahua Reef and Reef Runway Lagoon

The offshore area fronting Hickam AFB consists of three distinct habitats: a stand of mangrove, an extensive shallow reef flat, and a deeper reef slope. The reef, known as Ahua Reef, is bordered on both sides by deep dredged channels-the Pearl Harbor main entrance channel and the Hickam Harbor entrance channel. The shallow reef flat is heavily silted inshore; it progresses offshore toward a mixture of limestone reef, coral rubble, and sand. In addition, there is a sandy lagoon, referred to as the Reef Runway Lagoon, between the reef runway and shore.

Ahua Reef near Hickam AFB has been dredged on both its west and east margins. A stand of mangroves extends approximately 328 feet (100 m) from shore, with a gravel spit of coral rubble running perpendicular from the mangroves for 738 feet (225 m) (Bailey-Brock 1979). The dredged, eastern edge of the reef is encrusted with coralline algae, and there are sabellid worms in the cracks in the reef. Most of the reef flat consists of a very shallow, highly sedimented reef flat. Dominant substrate types on the reef include sand, limestone reef, and coral rubble. Living hard coral makes up a very small portion of the entire reef area (less than 2 percent). The reef slope substrate is dominated by limestone reef with some coral rubble.

Species Diversity

Over 2,000 individuals from 80 species and 24 families of fish were observed in transects in marine waters off Hickam AFB (EA 1996a). The numbers of species, number of individuals, biomass, diversity, and evenness all showed a large degree of variability, particularly between habitats. Biomass density for the entire study area was relatively low, approximately 1.0 pounds (lb) per 100 ft^2. This is a reflection, in part, of the fact that many of the individuals observed were juveniles and that reef flat productivity is low. Diversity and biomass were substantially higher on the reef slope, compared to the reef flat and mangrove area, although species abundance was distributed quite evenly within this habitat. Evenness in the reef flat and mangrove habitats was high as a result of the low number of species and individuals, with no species being numerically dominant.

Fish---Parrotfishes, followed by surgeonfishes and goatfishes, were the numerically dominant families of fish observed on all transects. Most of the parrotfish were mixed schools of juveniles, and most surgeonfishes were small solitary individuals such as ma'i'i'i (*Acanthurus nigrofuscus*), kole (*Ctenochaetus strigosus*), and convict tang (*manini, triostegus*). Goatfish and surgeonfish were the dominant fish families by biomass. Most large fish were found on the reef slope. The dominant species on the reef flat was the small (approximately 2.4-3.1 inch) belted wrasse (*'omaka, Stethojulis balteata*). The most abundant fish species by weight was the yellowfin goatfish (*weke 'ula, Mulloidichthys vanicolensis*). This species formed large schools on the reef slope but was observed only in 10 percent of the transects. The convict tang also formed schools, both on the reef slope and along the reef crest, and were found in 35 percent of the transects. Although not observed during field studies, seven species of sharks and two species of rays may also be present in the waters just offshore (Lowe 1997). These are listed below.

- sandbar shark (mano, *Carcharhinus plumbeus*)
- tiger shark (niuhi, *Galeocerdo cuvier)*
- scalloped hammerhead shark (mano-kihikihi, *Sphyrna lewini*)
- blacktip reef shark (mano pa'ele, *Carcharhinus melanopterus*)
- whitetip reef shark (mano-lala-kea, *Triaenodon obesus*)
- Oceanic blacktip shark (mano, *Carcharhinus limbatus*)
- Galapagos shark (mano, *Carcharhinus galapagensis*)
- Hawaiian stingray (hihimanu, *Dasyatis brevis*)
- spotted eagle ray (hailepo, *Aetobatus narinari*)

Invertebrates---There were 11 species of live coral, four species of coral relatives, and 12 other megainvertebrate species observed on transects off of

Hickam AFB (EA 1996a). Cauliflower coral (*Pocillopora meandrina*) was the most commonly observed species of coral in all habitats. This species is an important colonizer and inhabits shallow, wave-exposed areas. Finger coral (*Porites lobata*) and the encrusting rice coral (*Montipora patula*) were also encountered with some regularity in the deeper reef slope habitat. None of the zoanthids or octocorals were particularly abundant on the reef. Although not observed, jellyfish may be present.

Very high densities of chaetopterid polychaete worms were found, covering much of the subtidal shoreline along Ahua Reef. These organisms lead to retention of sediment that would otherwise be transported closer to shore. These chaetopterid polychaetes appear to be stable and provide suitable habitats for diverse assemblages of other invertebrates. The rock boring urchin (*Echinometra mathaei*) was by far the most abundant megainvertebrate found at the study site. This species occupies a wide variety of habitats, from near shore waters to wave-washed reef crests, and it was dominant in both the reef slope and reef flat areas. The black long-spined urchin (wana, *Echinothrix calamaris*) was more common on the reef flat than the slope, while the collector urchin (wana, *Tripneustes gratilla*) was most commonly observed on the reef slope. The sea cucumber (*Holothuria atra*) was observed only in the sandy habitats within the reef flat, where it is an active processor of sediment.

Algae---Twenty species of red algae, five species of brown algae, and five species of green algae were identified during 1996 surveys (EA 1996a). The shallow reef flat habitat is dominated by two introduced red algae, *Acanthophora spicifera* and *Gracilaria salicornia*, which cover extensive portions of the reef flat. *Hypnea cervicornis*, another common red algae, was found growing in the form of epiphytes on larger seaweeds. Two edible seaweeds, ogo (*Gracilaria bursapastoris*) and limu manuauea (*G. coronopifolia*), were frequently observed on the reef flat, where they are reported to be harvested with some regularity. The reef slope was characterized by calcareous crustose species such as *Hydrolithon* spp. and *Porolithon* spp. These crustose species thrive in areas of higher wave exposure and current and are important reef builders in Hawaii.

The dense thickets of macroalgae on the reef flat at Ahua Reef indicate that this habitat has probably been adversely affected by dredging, sedimentation, and excessive nutrient input. Poorly treated sewage can raise nutrient levels in the coral ecosystem, which promotes the growth of algae. Normally, herbivorous fish, invertebrates, and turtles graze on these algae, but if the algae become too concentrated they can smother the coral polyps. Pollution from the nearby military bases, commercial airport, and sewage outfall may also be factors controlling reef health. Goal 10 in Chapter 8 provides objectives and strategies to offset these adverse effects to the coral reef community.

6.1.3 Terrestrial Habitats and Species

Three terrestrial habitat types were classified on Hickam AFB: wetlands (including sandflats), second-growth forest, and turf areas (lawns, fields, and golf courses). A description of the characteristics and typical species of each of those habitat types follows. The area of each habitat type is shown in Table 6.1-2.

TABLE 6.1-2 AREA OF TERRESTRIAL WILDLIFE HABITAT TYPES ON AND ADJACENT TO HICKAM AFB[1]

Habitat Type	Acres
Wetlands	49.0
Second-growth forest	150.9
Turf	1384.1
All types	1584.0
[1]Area of canals not included	

6.1.3.1 Wetlands

Most of the wetlands at Hickam AFB are located in flat or depressional areas in the southern portion of the base, along the coastline, and along the edge of the channel in Kumumau'u Canal and Manuwai Canal. Wetlands are divided into three habitat types: shoreline wetlands, ephemeral emergent wetlands, and canal wetlands. Although the canals were discussed previously in Section 6.1.2, terrestrial species associated with the canals are addressed in this section.

Shoreline Wetlands

Shoreline wetlands at Hickam AFB include mangrove-dominated shrublands and sand beaches. Two mangrove wetlands occur along the shoreline of Mamala Bay near the entrance to Pearl Harbor. These wetlands are dominated by a dense growth of mangrove trees ranging in height from 6 to 12 feet. Under the trees is a tangle of prop roots and numerous mangrove saplings, 2-3 feet tall. A large patch of pickleweed occurs along the northeastern edge of one mangrove area. These wetlands are tidally inundated on a regular basis, and a shallow, brackish water table is present. The National Wetlands Inventory (NWI), using the USFWS system of classification, determined that the mangrove portion of these wetlands should be classified as marine or estuarine, intertidal, scrub-shrub, regularly inundated (M2SSN or E2SSN). The shoreline areas dominated by pickleweed can be classified as marine, intertidal, emergent, persistent, regularly inundated (M2EM1N).

The mangrove shrublands provide a limited amount of cover, nesting, and feeding habitat for songbirds. The inundated prop roots also provide cover (i.e., protection from predatory fish and birds) for juvenile marine and brackish-water fish. Gently sloping shorelines covered with pickleweed and dense mangrove are unsuitable for use by shorebirds, but may be used by non-native species, such as common myna (*Acridotheres tristis*), sparrows, and finches.

Non vegetated sand beaches are generally considered not to be jurisdictional wetlands (USACOE 1987). The sand beaches along the shoreline of Hickam AFB (14.5 acres) are largely unvegetated and do not display hydric soil characteristics. However, they are regularly flooded by tidal inundation. These

wetlands are classified by the NWI as estuarine, intertidal, unconsolidated shore, sand, regularly flooded (E2US2N).

Sand beaches generally have low value as wetlands, except as foraging habitat for sandpipers and other shorebirds. Several small sand islands near the mouth of the Manuwai Canal are used by shorebirds and waterbirds for resting and foraging. During a January 1996 site visit, two black-necked stilts (*ae'o*, *Himantopus mexicanus knudseni*) (federally classified as endangered) were observed flying from the lagoon up Manuwai Canal (EA 1996a). Since this species is known to use the lagoon for resting and feeding, it was assumed that these individual birds had been at the lagoon. The sand islands have potentially suitable nesting habitat for the black-necked stilt, but the high level of human activity in the area, combined with easy access for predators, may preclude their use of the islands for nesting.

Additional species observed on sand beaches at the base include Pacific golden plover (kolea, *Pluvialis fulva*), wandering tattler (*'ulili*, *Heteroscelus incanus*), ruddy turnstone ('akekeke, *Arenaria interpres*), and sanderling (*hunakai*, *Calidris alba*) (EA 1996a). In addition to the sand islands, wading habitat is also available along a small stretch of shoreline. A mongoose (*Herpestes auropunctatus*), an introduced predator, was observed scampering over rocks in the intertidal zone.

Ephemeral Emergent Wetlands

Ephemeral emergent wetlands are those that are temporarily ponded and vegetated with rooted, herbaceous plant species. Three wetland areas occur in the flat plain that comprises Fort Kamehameha. Two of the wetlands lie to the north of the meteorological station, and the third is located to the south and west of Seaman Avenue and north of Hope Street. A fourth wetland occurs south of the drainage ditch near the explosives storage area and the Prime BEEF training area. They all have similar hydrology, in that they receive surface runoff from higher elevations and brackish ground water from the shallow water table. During the rainy season, following periods of heavy precipitation, the areas may have more or less continuous surface water, or scattered ponded areas. During the dry season, the exposed soil dries out and becomes highly saline, with a thin, white salt crust left on the surface from the evaporation process. Many barren patches occur within these areas. The vegetated areas in these wetlands are dominated by pickleweed, which is probably clustered in the areas of highest soil salinity, with scattered clumps of kiawe shrubs occurring primarily on the elevated areas. These wetlands should be classified as palustrine, emergent, persistent, seasonally flooded (PEM1 C).

When low-lying areas pond water following heavy rain or excessive irrigation, they provide foraging opportunities for a variety of shorebirds and wading birds. Cattle egrets (*Bubulcus ibis*), golden plovers, and black-necked stilts have been observed using these wetlands (EA 1995). Not all of the ephemeral ponding areas at Hickam AFB have been identified on habitat maps, because of their sporadic and irregular occurrence.

Canal Wetlands

Wetlands occur within the channels of Manuwai Canal and Kumumau'u Canal, and are well-defined by the canal banks. Mangrove, the dominant plant species in these areas, has been cut back in both canals in an effort to maintain water conveyance capacity. The canals are classified as estuarine, subtidal, open water, subtidal inundation, excavated (E10WLx).

In the lower portion of the Manuwai Canal, from the mouth to the Worchester Avenue Bridge, small sandbars bordering the water may be used by plover, tattler, and other shorebirds. Along the middle portion of the canal, above the Worchester Avenue bridge, are steep-cut banks that are not suitable for shorebirds, but may be utilized by egrets and herons for foraging. A cattle egret was observed roosting in a large kiawe (*Prosopis pallida*) along the canal just above the bridge. The lower and middle portions of the canal have recently been cleared of the dense bankside mangrove, which had previously provided limited habitat for waterbirds. Currently the intricate mangrove root systems remain along the watercourse and provide foraging opportunities for larger wading birds (e.g., herons, egrets) that may use the roots to hunt from.

The upper portion of the canal, north and east of Kuntz Avenue, is characterized by a variety of emergent vegetation, including cattail (*Typha sp.*) and California grass (*Brachiaria mutica*). Clumps of emergent vegetation are interspersed with open water, creating a mosaic pattern that is preferred by the Hawaiian coot ('alae ke'oke'o, *Fulica americana alai*) and common moorhen or ('alae 'ula, *Gallinula chloropus sandwicensis*). However, these species were not observed during the site visit and have not been recorded in the Manuwai Canal. The only evidence of avian activity in the upper canal was whitewash on vegetation and along the banks, indicating the presence of black-crowned night-heron ('auku'u, *Nycticorax nycticorax hoactli*).

The other canal, Kumumau'u, also provides some habitat for migratory shorebirds and waterbirds. The lower portion of the canal, from the mouth up to the Worchester Avenue bridge, has several sandbars suitable for use by shorebirds. The only bird observed on the sandbars during the 1996 site visit was golden plover. During previous site surveys (EA 1995), a wandering tattler and sanderling were observed resting and preening at these sandbars. One black-crowned night-heron was observed in the upper portion of the canal, and it is possible that this area is also used by cattle egret, although none were observed. Because of the steep banks and deep water in the upper canal, there is limited habitat for shorebirds or small wading birds.

6.1.3.2 Second-Growth Forest

Second-growth forest on Hickam AFB is characterized by large kiawe, often mixed with koa-haole (*Leucaena glauca*) and Christmas berry (wilelaiki, *Schinus terebinthifolius*). Second-growth forest is used by a variety of exotic species for foraging, nesting, and cover. During a 1996 site visit, species of birds observed in this habitat were northern mockingbird (Mimus polyglottus), northern cardinal (*Cardinalis cardinalis*), white-rumped shama (*Copsychus malabaricus*), Japanese bush warbler (*Cettia diphone*), and Japanese white-eye (*Zosterops japonicus*) (EA 1996a). In addition to these species, previous site investigations at Hickam AFB have recorded several black-crowned night-herons roosting in the tops of tall (>20 feet) kiawe in large forested areas (EA

1995). Although no owls were observed during site investigations, these large trees also provide roosting and nesting sites for barn owl (*Tyto alba*).

During the 1995 surveys, evidence of cat (*Felis domesticus*), mongoose, and rat (*Rattus sp.*) activity, including runways, dens, tracks, and scat, was often found in second-growth forest and shrubland habitat (EA 1995). Mice (*Mus sp.*) are also expected to be present, although none were observed. In some areas, shells of the African snail (*Euglandina sp.*), an introduced predatory snail, were abundant on the ground.

6.1.3.3 Turf Grass

Turf areas at Hickam AFB are widely used by exotic species that include sparrows, doves, and other ground feeders. Lawn, fields, and golf courses are also used extensively by the Pacific golden plover, the most abundant migratory shorebird in Hawaii (Hawaii Audubon Society 1993; Pratt et al. 1987). Wintering plover set up and defend foraging territories in these areas and return to them year after year (Bruner 1996a). Numerous plover were seen during January 1996 site visits (EA 1996a). Johnson and Johnson (1993) surveyed plover at all golf courses on Oahu and found that the Hickam AFB golf course had the highest density of plover on the island. Another migratory shorebird likely to use these habitats for foraging is the ruddy turnstone. None were observed during the 1996 survey, but they have previously been recorded on lawns, fields, and golf courses (Bruner 1996b). The mammals observed in turf habitats were primarily domestic cats and dogs. Other mammals expected to utilize this habitat include mongoose, rats, and mice. The acreage estimate is based on the turf areas (from Figure 6-1), including herbaceous, ruderal areas.

6.1.4 Rare, Threatened, and Endangered Species

Since the Endangered Species Act of 1973 (as amended) provides protection of species that are federally listed as Threatened and Endangered, the presence of any listed species in the vicinity of the installation could affect operation and management of the facility. A list was generated of RTE species that potentially occur or are known to occur on or adjacent to the installation. This information was used in developing management plans and protection measures for RTE species. The list of plant species (Appendix C) and animal species (Appendix D) indicates which species have RTE status for each installation, including Hickam AFB.

6.1.4.1 RTE Plant Species

Searches of the Hawaii Natural Heritage Program (HNHP) and USFWS species databases indicated that no RTE plant species are known to occur on or near Hickam AFB (HNHP 1995; USFWS 1994,1996). During field surveys conducted in January 1996, no RTE species were observed in areas of unmanaged vegetation, where the surveys were focused (EA 1996a). Given the intensity and long history of disturbance on Hickam AFB and the replacement of virtually all native vegetation with exotic plant species, it is highly unlikely that any RTE plant species would occur on the installation.

6.1.4.2 RTE Vertebrate Animal Species

Two federally listed species, the endangered black-necked stilt and the threatened green sea turtle were observed on Hickam AFB during field surveys in January 1996 (EA 1996a). The black-necked stilt (ae'o, *Himantopus mexicanus knudensi*) observations were made in the Reef Runway Lagoon area in the vicinity of the mouth of Manuwai Canal. Stilts were previously observed foraging in ephemeral ponds on other parts of the installation (EA 1995). Black-necked stilts have also been recorded in the vicinity of the Reef Runway and on the Waipio Peninsula in Pearl Harbor, 2-3 miles away (HNHP 1995).

An injured owl recently captured at the base commissary was identified by Department of Land and Natural Resource biologists as the state endangered pueo, or short-eared owl (*Asio flammeus sandvcicensis*). The current number and distribution of these owls on Oahu is unknown. This diurnal owl is found in a variety of habitats, from open fields to forests. It nests on the ground in grassy areas, and predation by cats, dogs, and mongooses is a major factor limiting its population on Oahu. Several areas at Hickam AFB exhibit suitable habitat conditions for use by the short-eared owl, but it is highly unlikely that this species would nest successfully on the installation, because of the abundance of ground predators. The pueo has been recorded on numerous occasions near Hickam AFB on the Waipio Peninsula in Pearl Harbor (HNHP 1995).

Only a few scattered occurrences of the federally endangered Hawaiian hoary bat (ope'ape'a, *Lasiurus cinereus semotus*) have been reported on Oahu. This rare mammal forages in coastal and urban areas and in upland forests. The largest populations are found on Kauai and Hawaii, where they can often be seen capturing insects over coastal ponds and bays. It is possible that this endangered species would utilize suitable habitats on Hickam AFB, but due to its rarity on Oahu such use would likely be infrequent (Bruner 1996a).

Habitat for the federally endangered Hawaiian coot ('alae ke'oke'o, *Fulica americana alai*), and federally endangered common moorhen, ('alae 'ula, *Gallinula chloropus sandvicensis*) occur in the Manuwai Canal (see Section 6.2.1.2), but these species have not been recorded in the canal. The common moorhen, however, has been recorded in the tidal flats near Fort Kamehameha (HNHP 1995), and both species have been recorded on the Waipio Peninsula in Pearl Harbor, 2-3 miles away from Hickam AFB. The Hawaiian duck, (koloa maoli, *Anas wyvilliana*), has also been recorded on the Waipio Peninsula.

Three federally protected marine species occur, or potentially could occur, in waters off Hickam AFB: threatened green sea turtles (honu, *Chelonia mydas*), and endangered Hawaiian monk seals ('ilio-holo-i-ka-uaua, *Monachus schauinslandi*) and humpback whales (kahola, *Megaptera novaeangliae*). Green sea turtles are fairly common around Oahu, and both adult and juvenile turtles were observed in the vicinity of several transects at Hickam AFB. The high algal cover and sheltered areas at Hickam AFB may provide food and habitat for these turtles. Hawaiian monk seals have been recorded at Iroquois Point, which is across the entrance of Pearl Harbor from Hickam AFB.

6.1.4.3 RTE Invertebrate Animal Species

Based on available information, there are no known occurrences of RTE invertebrate species at Hickam AFB. Endangered land snails are not expected to occur at Hickam AFB, because the native forest habitat that supports the snails is not found on the installation.

6.3 HICKAM POL PIPELINE

6.3.1 Vegetation

Significant natural features at Kipapa FSA include Kipapa Stream and valley walls that support extensive areas of second-growth forest. The landscape of Waikakalaua FSA is dominated by grassland. The site has been cleared, but only one building was ever constructed here. There are no natural features of note at this site.

6.3.1.1 Regional and Historic Natural Vegetation

Kipapa FSA and Waikakalaua FSA are located in a relatively dry, lowland climate. As in many mid to lowland areas in Hawaii, the native vegetation that once occurred in the vicinity of these installations has been removed by intensive grazing and forest cutting and has been replaced largely by introduced species. There are no areas in the region that support any native-dominated vegetation communities. Military activities, horse grazing, residential development, and pineapple cultivation are the primary land uses in this region. Historically, much of the area around the installations was pineapple fields. In recent years, housing has been developed extensively around Mililani Town, which is about half a mile east of Waikakalaua FSA and immediately above the gulch where Kipapa FSA is located.

Many of the introduced tree species on Kipapa FSA, such as the Chinese banyan (Ficus microcarpa) and the eucalyptus trees in the forest around Waikakalaua FSA, are the result of plantings and subsequent spread of these species as part of forestry programs that date back to the late 19th century. As is evident from the fire signs noted on the Kipapa Gulch slopes, forests dominated by silk oak, Formosan koa, and koa-haole are susceptible to fire. Guinea grass (*Panicum maximum*) appears to be the primary species that has invaded following fire disturbance. Horse grazing and pineapple cultivation have probably occurred in the area around Waikakalaua FSA at least over the past 100 years.

Kipapa FSA is situated at the bottom of a steep-walled gulch through which Kipapa Stream flows in a more or less southerly direction. Immediately upstream of Kipapa FSA is land managed by the Army, which was previously used for ammunition storage. There is a residential area on the west side and pineapple farms on the east side of the terrain above the gulch. Waikakalaua FSA is surrounded by non-native forests and shrublands in Waikele Gulch and by pineapple fields and pasture.

6.3.1.2 Existing Native Vegetation Cover Types

The grounds of Waikakalaua FSA are entirely developed and landscaped; most of the Kipapa FSA site is covered by unmanaged vegetation, which is

dominated by non-native species. No native vegetative cover is found on either site.

6.3.1.3 Existing Non-Native Vegation Cover Types

The following sections describe cover types on and adjacent to each FSA.

Kipapa FSA

Kipapa FSA includes managed landscaped areas along the access roads and within the fenced area near the fuel storage tanks and operations buildings. Infrequently mowed turf and weedy forbs cover most of these areas. Landscape plantings include a number of old monkeypod trees (ohai, *Samanea saman*), shrubs of a red-flowered Hibiscus cultivar, wedelia (*Wedelia trilobata*), purple-flowered bougainvillea (*Bougainvillea spectabilis*), several hybrid colored ti leaf plants (ki, *Cordyline fruticosa*), and a small planting of young coconut palms (niu, *Cocos nucifera*).

The following plant associations were identified in unmanaged areas of Kipapa FSA: koa-haole shrubland, mixed introduced forest, silk oak/koa-haole shrubland and forest, Guinea grass/mixed shrub mosaic, and California grass grassland (Table 6.3-1). Very few native species and no native plant communities occur on the site.

TABLE 6.3-1 AREA OF VEGETATION COVER TYPES ON KIPAPA FSA

Cover Type	Acres
Koa-haole shrubland	23.4
Mixed introduced forest	16.0
Silk oak/koa-haole shrubland and forest	6.3
Guinea grass/mixed shrub mosaic	4.6
California grass grassland	0.6
Landscaped area	2.6
All types	53.5

Koa-hoale Shrubland--- Koa-haole shrubland covers the majority of the unmanaged portions of Kipapa FSA. It occurs on some portions of the slopes of Kipapa Gulch and also on parts of the more or less level gulch floor adjacent to the fenced grounds. Koa-haole shrubs form a dense cover 10--15 feet tall, with the plants somewhat taller on the floor of the gulch, where the soil is deeper and moister. In most places, dense clumps of Guinea grass up to 3 feet tall are found between the koa-haole shrubs. In some places on the gulch floor, white shrimp plant (*Justicia betonica*) replaces Guinea grass as the most abundant ground cover.

Mixed Introduced Forest---This vegetation type is associated with the moist microclimate created by Kipapa Stream and is composed of a number of introduced tree species which form a closed-canopy forest in most places. The forest is about 25-30 feet tall and consists of a variety of tree species such as monkeypod, Chinese banyan, African tulip (*Spathodea campanulata*), common ironwood, China berry ('inia, *Melia azedarch*), and Formosan koa.

Trees of albizia and gunpowder, or charcoal tree (*Trema orientalis*), are more numerous than the other species and tower above the forest canopy. The understory is open and heavily shaded. Java plum trees, koa-haole, and Guinea grass are common along the stream banks.

Silk Oak/Koa-Haole Shrubland and Forest--- On the slopes above the Old Kamehameha Highway, on both sides of the southeast site boundary is a shrubland and forested area dominated by silk oak ('oka kilika, *Grevillea robusta*). A few small stands of various Eucalyptus species, mostly E. robusta, are also present, along with Formosan koa. Thickets of koa-haole form a dense understory.

Guinea Grass/Mixed Shrub Mosaic--- A grass/shrub association dominates on the steep gulch slopes. It consists of Guinea grass covered slopes with scattered pockets of shrubs that include koa-haole, Christmas berry, and 'a ali'i (*Dodonaea viscosa*).

California Grass Grassland--- This monotypic vegetation type occupies only a small area of the unmanaged portion of Kipapa FSA near the base of some steep slopes in the bottom of Kipapa Gulch. Runoff from upslope and the Old Kamehameha Highway is channeled into this low-lying area. California grass (*Brachiaria mutica*) forms a dense ground cover, with only a small clump of koa-haole shrubs occurring at the north end of this area.

Waikakalaua FSA

The vegetation on Waikakalaua FSA consists entirely of turf, with scattered ornamental shrubs and trees. The turf is made up primarily of pitted beard grass (*Bothriochloa pertusa*), but patches of Bermuda grass (manienie, *Cynodon dactylon*) are common around the buildings near the entrance to the site. Common ornamental species, clustered primarily near the entrance, include coconut (niu, *Cocus nucifera*), bougainvillea (*Bougainvilla glabia*), lemon (*Citrus limonia*), plumeria (Plumeria hybrid), panax (*Polyscias guilfoylei*), and ti (ki, *Cordyline fruticosa*).

The area outside of the installation to the north is managed as pineapple fields, but the remainder of the vegetation surrounding the site, largely unmanaged, consists of five distinct vegetation types: eucalyptus dominated forest, guava/Christmas berry shrubland, silk oak/Christmas berry shrubland, California grass grassland, and koa-haole shrubland (Table 6.3-2).

TABLE 6.3-2 AREA OF VEGETATION COVER TYPES ON WAIKAKALAUA FSA

Cover Type	Acres
Eucalyptus forest	0.8
Pineapple fields	0.0
Guava/Christmas berry shrubland	0.0
Silk oak/Christmas berry shrubland	0.3
California grass grassland	0.0
Koa-haole shrubland	0.0
Landscaped area	22.4
Barren ground	3.2
All types	26.7

Eucalyptus Forest--- Eucalyptus forest occurs along the east boundary outside of the site and along a portion of the south perimeter. This cover type includes several eucalyptus species, ranging in height from 50 to 70 feet. The understory is open, with sparse shrubs of koa-haole (*Leucaena leucocephala*) and Christmas berry (wilelaiki, *Schinus terebinthifolius*).

Pineapple Fields--- The entire northwest boundary (the boundary runs southwest to northeast) of the installation is bordered by extensive pineapple fields in active cultivation. The fields had recently been harvested and the pineapple plants plowed under (January 1996).

Guava/Christmas Berry Shrubland--- The northwest half of the area bordering the southwest boundary is dominated by guava (kuawa, *Psidium guajava*) and Christmas berry shrubs. The area is open, with sparse shrubs ranging in height from 6 to 12 feet. Lower-growing lantana shrubs are abundant in certain areas.

Silk Oak/Christmas Berry Shrubland--- Silk oak/Christmas berry shrubland occurs along the southeast half of the southwest boundary and along the southeast boundary. The landscape in this area is dominated by scattered silk oak trees, ranging in height from 25 to 30 feet, and clumps of Christmas berry shrubs 12-15 feet tall. Patches of more open areas occur amid these trees and shrubs and are dominated by California grass and Guinea grass, with occasional guava and koa-haole shrubs scattered throughout.

California Grass Grassland--- California grass occurs in a small area just outside the south boundary of the installation. It forms a dense monotypic patch that is surrounded by the silk oak/Christmas berry shrubland.

Koa-Haole Shrubland--- Koa-haole shrubs form a dense cover just outside the southeast corner of the site. They average approximately 12 feet in height interspersed among dense clumps of Guinea grass up to 3 feet tall.

6.3.2 Aquatic Habitats and Species

6.3.2.1 Kipapa FSA

Kipapa Stream flows through the valley bottom of Kipapa FSA. Kipapa Stream, with a length of 2,770 feet within the Kipapa FSA, is a free flowing, low-gradient stream with a slope of about 3 percent. The stream channel is deeply incised into bedrock and probably contains most flows within its banks. Flows can be quite extreme in this area, as evidenced by the more than 4 foot drop in water depth from flood flows just two days prior to the observations made in January 1996. The channel includes three main macrohabitat types: riffles (51.4 percent), runs (32.2 percent), and pools (16.4 percent) (EA 1996c). This section of Kipapa Stream also includes one 278-foot simple island stabilized by a heavy growth of grasses.

Apparently, most fine sediments are transported through this reach; substrates throughout the reach were predominantly boulders and cobbles. Despite the high recent flows and heavy rains, no raw or eroding banks were observed. Recent water quality measurements for temperature, pH, and dissolved oxygen indicated that the stream was well within acceptable criteria for aquatic life (EA 1996c).

Species Diversity

The diversity of aquatic fauna in the reach of Kipapa Stream on Kipapa FSA was judged to be poor, even by Hawaiian standards. While recent flooding may be a factor that explains part of the low observed diversity, the presence of pools, large boulders and cobbles, and riparian vegetation (which can provide refugia from high water velocity) limits the importance of flooding as a controlling factor. No obvious alternative factors were noted in the reach.

Seven species of aquatic fauna were found in 1996 surveys in Kipapa Stream, including four fish species, one crustacean, one mollusk, and one amphibian (EA 1996c). The most common species observed was the mosquitofish (*Gambusia affinis*). Only two of the species, shrimp ('opae kala'ole, *Atyoida bisculata*) and the thiarid snail (*Melanoides sp.*) are endemic to Hawaii. Though not observed in the 1996 surveys, the only native fishes that might be found in Kipapa Stream are "gobies" in the families Eleotridae and Gobiidae.

6.3.2.2 Waikakalaua FSA

There are no aquatic habitats on or immediately adjacent to Waikakalaua FSA.

6.3.3 Terrestrial Habitats and Species

Kipapa FSA--- Kipapa FSA shows greater biological diversity than does Waikakalaua FSA, in that it includes more complex plant associations and four habitat types: turf, second-growth forest and shrubland, grassland, and wetlands (including the Kipapa Stream channel and the drainage ditch) (Table 6.3-3). The California grass grassland is listed as a grassland habitat type (not wetland), because that is the characteristic feature (not standing water).

TABLE 6.3-3 AREA OF WILDLIFE HABITAT TYPES ON KIPAPA FSA

Habitat Type	Acres
Turf	2.6
Wetland	3.7
Grassland	0.6
Second-growth forest and shrubland	48.6
All types	55.5

A total of 12 species of birds were observed at Kipapa FSA: one migratory shorebird and 11 introduced land birds (EA 1996c). No mammals were seen during the site visit to Kipapa FSA, but dogs (*Canis familiaris*), cats (*Fells domesticus*), mongoose (*Herpestes auropunctatus*), rats (*Rattus sp.*), and mice (*Mus sp.*) are likely to occur on the property. The Hawaiian hoary bat, or ope'ope'a, was not observed at Kipapa FSA, although marginal habitat is available.

Waikakalaua FSA--- Overall biological diversity at Waikakalaua FSA is quite low due to the lack of complexity in the dominant turfgrass habitat type. Some second-growth forest and shrubland can be found at Waikakalaua FSA as well (Table 6.3-4). Primarily exotic bird species occur at this site.

TABLE 6.3-4 AREA OF WILDLIFE HABITAT TYPES ON WAIKAKALAUA FSA

Habitat Type	Acres
Turf	22.4
Second-growth forest and shrubland	1.1
All types	25.5

A total of 11 species of birds were observed at Waikakalaua FSA during the 1996 site visit: one migratory shorebird and 10 introduced land birds (EA 1996c). No mammals were seen during the site visit to Waikakalaua FSA. The fence that surrounds the property and the limited habitat found on the site probably precludes extensive use of the area by mammals (Bruner 1996b).

6.3.3.1 Turf

Kipapa FSA--- Turf habitat is widely used by non-native species, such as sparrows, doves, and other ground-feeders. Several Pacific golden plovers were observed in lawn areas during the site surveys.

Waikakalaua FSA--- At Waikakalaua FSA, small flocks of common waxbill (*Estrilda astrild*) and red avadavat (*Amandava amandava*) were taking advantage of the seed on the lawn grasses and were observed feeding throughout the site. The only native bird believed to use Waikakalaua FSA is the Pacific golden plover. In addition to the Pacific golden plover, the turf areas at Waikakalaua FSA may be used by migratory ruddy turnstone ('akekeke, *Arenaria interpres*). This species often uses lawn areas for foraging.

6.3.3.2 Second-Growth Forest and Shrubland

Kipapa FSA--- Species observed in forest habitat at Kipapa FSA included northern cardinal (*Cardinalis cardinalis*), red-crested cardinal (*Paroaria coronata*), red-vented bulbul (Pycnonotus cafer), Japanese white-eye (*Zosterops japonicus*), white-rumped shama (*Copsychus malabaricus*), and Japanese bush warbler (*Cettia diphone*).

Waikakalaua FSA--- The surrounding forest and shrubland habitat around Waikakalaua FSA may be used by mongoose, rats, and mice, and also by a variety of introduced bird species, including sparrows, finches, and doves. Second-growth forest and shrubland are typically used by a variety of exotic species for foraging, nesting, and cover.

6.3.3.3 Wetlands

Kipapa FSA--- Two wetlands have been identified on Kipapa FSA. One probable jurisdictional wetland was identified on this site in a small depressional area located in the bottom of Kipapa Gulch near the stream. The vegetation in this area is dominated by California grass. The area lies within the floodplain of Kipapa Stream, and so can be assumed to flood periodically. This wetland is rated low for wildlife habitat, although some birds may nest and take cover in the tall grass.

The channel of Kipapa Stream qualifies as a non-jurisdictional wetland in that wetland hydrology is evident, but most of the channel is unvegetated. The channel probably lacks vegetation because of the rapid flows that follow high rainfall events and the intermittent nature and flashy hydrology of this stream. Although streamflow was high during the surrey, during lower flow it is possible that shorebirds and native waterbirds would use this portion of Kipapa Stream. Although none were observed during the surrey, native species that may use the stream habitat include the black-crowned night-heron and wandering tattler. These two species forage along streams and will follow streams well into the interior of the island (Hawaii Audubon Society 1993).

Waikakalaua FSA---- There are no wetlands on Waikakalaua FSA.

6.3.4 Rare, Threatened, and Endengered Species

No RTE plant or animal species occurrences have been recorded at either Kipapa FSA or Waikakalaua FSA. However, there is potentially suitable habitat for the Hawaiian hoary bat at both facilities and for the Hawaiian duck at Kipapa.

6.3.4.1 Plant Species

Searches of the HNHP and USFWS species databases (HNHP 1995; USFWS 1994, 1996) indicated that the nearest recorded occurrence of an RTE plant species to these facilities is in Kipapa Gulch, approximately 2.3 miles east of Waikakalaua FSA and one-half mile northeast of Kipapa FSA. The species, known as nehe (*Lipochaeta lobata var. lobata*), is a low shrub that grows on dry slopes. The last recorded observation of the species in the area was in 1935 (HNHP 1995). Much of the vegetation in Kipapa Gulch has most certainly been altered significantly since the 1930s. None of the plants observed during the January 1996 field studies is a rare, threatened, or endangered species (EA 1996c). Based on this information, it is highly unlikely that any RTE plant

species occur on or in the areas immediately surrounding Kipapa and Waikakalaua FSAs.

6.3.4.2 Animal Species

Kipapa FSA---There are no known occurrences of threatened and endangered animal species on or near the Kipapa FSA (HNHP 1995), but two RTE species may potentially use habitat at Kipapa FSA. The Hawaiian duck (*koloa maoli*, *Anas wyvilliana*) is a federally endangered species that has been reintroduced to Oahu, where it had become extirpated. This species uses a variety of wetlands, including streams like Kipapa. None were recorded on this survey, but at times when the stream is not flooding, the Hawaiian duck may utilize the site (Bruner 1996b). The Hawaiian hoary bat was not recorded during the survey but may potentially be found roosting in the second-growth forest and may use the site while foraging. No endangered land snails would be expected to occur at Kipapa FSA, since these snails are generally found at elevations above 1,500 feet in native forest (Miller 1996 as cited in Bruner 1996b).

Waikakalaua FSA---There are no known occurrences of threatened and endangered animal species on or near Waikakalaua FSA (HNHP 1995). The Hawaiian hoary bat was not observed during the survey, but may potentially roost and forage in the vicinity (Bruner 1996b). As at Kipapa FSA, no endangered land snails would be expected to occur at Waikakalaua FSA.

7.1 HICKAM AFB

The coastal setting, the wetlands, and the extensive historical and archaeological potential of Hickam AFB provide both opportunities for resource enhancement and certain constraints to further development or intensification of base activities. Resource management issues generally relate to the need of ensuring flight safety, accommodating recreational needs of base personnel, improving drainage and water quality, and maintaining the visual quality of highly landscaped areas.

7.1.1 Natural Resources Opportunities and Constraints

Hickam AFB has a number of resource opportunities and constraints, shown in composite form in Figures 7-1A and 7-1B. The maps are composed of one or more data categories in selected GeoBase data layers listed in Table 7.1-1. These data categories were selected from the resource inventories because they pertain to specific resource opportunities or constraints.

7.1.1.1 Soils

Jaucas sand, 0-15 percent slopes (JaC), is found on approximately 69 acres in the Fort Kamehameha area. Jaucas sand has a severe wind erosion hazard where the vegetation has been removed, and consequently it has poor suitability for topsoil and road fill. Its capability classification for agriculture indicates very severe limitations that reduce the diversity of suitable plants or render areas unsuitable for cultivation. Thus, the area may be both difficult to vegetate and subject to wind erosion if left exposed.

Constraint: This soil type is considered a constraint because it requires special treatment and design considerations. To address this problem, implement BMPs for erosion and sediment control (Appendix F).

7.1.1.2 Hydrography

The canals and open drainage ditches are man-made watercourses that serve primarily to transport stormwater and irrigation runoff to the ocean. With the exception of the lower portion of Manuwai Canal, immediately adjacent to the golf course, none of the three canals has any natural-looking features. Shade and riparian cover are rare, with much of the riparian zone containing mowed grasses, pickleweed, and mangrove. Water quality conditions for aquatic life are poor in Kumumau'u and Manuwai canals and may be impacted by hazardous waste contamination, which is under study by the Installation Restoration Program (IRP). However, native freshwater and estuarine species were observed in the two canals. Predominantly marine species were observed in downstream reaches, and introduced freshwater and brackish-water species were observed in middle and upstream reaches.

Opportunity: Watercourses on Hickam AFB are considered opportunities for possible nonpoint source pollution control and cleanup, including sediment dredging, and for the preservation or enhancement of wetlands and riparian zones for wildlife.

Constraint: Enhancement of riparian zone for birds in some areas may be constrained by the base mission, which requires minimization of potential bird aircraft strike hazard (BASH) problems. There is very little native terrestrial wildlife in Hawaii other than birds and a bat (ope'ape'a). (See Section 9.3.1 for limitations to riparian zone enhancement.)

The presence of mangroves in the canals results in negative effects on native fish and wildlife. Mangrove is not native to Hawaii and is highly invasive, spreading rapidly throughout shallow water environments.

Constraint: Mangroves reduce the stormwater capacity of the canals and increase the risk of BASH in some areas by providing habitat for perching birds. To address this problem, implement the Watercourse Conveyance Enhancement Project (Section 10.4.2.4).

7.1.1.3 Flood Hazard

The 100-year return period flood hazard zone was determined in the Flood Insurance Study prepared by the Federal Emergency Management Agency (FEMA). This study shows the area of inundation associated with tsunami (sea waves of seismic origin) in the coastal area between the Reef Runway Lagoon and Motor Pool Canal.

Constraint: The flood hazard area is a potential constraint to the development of facilities that could be severely damaged. Any new projects in the hazard area need to incorporate flood protection measures into their design.

7.1.1.4 Vegetation Cover

Hickam AFB has relatively little unmanaged vegetation. Unmanaged vegetation that is dominated by two non-native species, pickleweed flats and mangrove, is shown on the composite map (Figure 7-1A, wetlands and wildlife habitat areas). These plant species are potential habitat for two federally endangered bird species. These habitats are also classified as wetlands.

Opportunity: Unmanaged vegetation associated with wetlands provides potential habitat for birds. Therefore, implement the Black-necked Stilt Radiotracking Project (Section 10.2.2.6) and the Wetland Enhancement Project at Fort Kamehameha (Section 10.3.2.4).
The composite maps (Figures 7-1A and 7-1B) do not show the extensive landscaped areas which contain abundant and diverse plantings of non-native, ornamental shrubs and trees (exotic species) and the areas of turf that are regularly mowed and dominated by grasses. These areas are shown on separate maps of turf and tree cover in this INRMP (Figures 6-1A and 6-1B, respectively).

Landscaped areas are important to the visual appearance of the installation. They have potential interpretive or educational value, and they provide habitat for the golden plover (native bird), exotic birds, and non-native animals.

Opportunity: Landscaped areas contribute to habitat for the golden plover and to the base's visual appearance. Therefore, implement the Grounds Maintenance and Urban Forestry Operational Component Plan (Section 10.6).

Opportunity: The abundance of urban trees presents a public relations opportunity for Hickam AFB to be designated a Tree City. Therefore, implement the Tree City USA Designation Project (Section 10.6.2.7).

7.1.1.5 Wildlife Habitat

Sandflats and wetlands, the main wildlife habitats of importance as resource opportunities, are the areas most in need of preservation and/or enhancement. They are shown on the composite maps (Figure 7-1A and 7-1B). These areas are the most important habitat for native (resident and migratory) and RTE species on Hickam AFB. Wetland habitats at Hickam AFB include mangrove areas and pickleweed flats. Sandflats are located adjacent to and near the shoreline of the Reef Runway Lagoon, and at the wetland reserve near Fort Kamehameha. These areas provide suitable forage for shorebirds and wading birds. Two of the larger canals, the Manuwai and Kumumau'u, and smaller ditches also provide some wetland habitat.

Opportunity: Sandflats and wetlands provide important habitat for native and RTE species. Implement the Permanent Wetland Database Project (Section 10.3.2.2) and the Long-term Monitoring of Wetland Functions Project (Section 10.3.2.3).

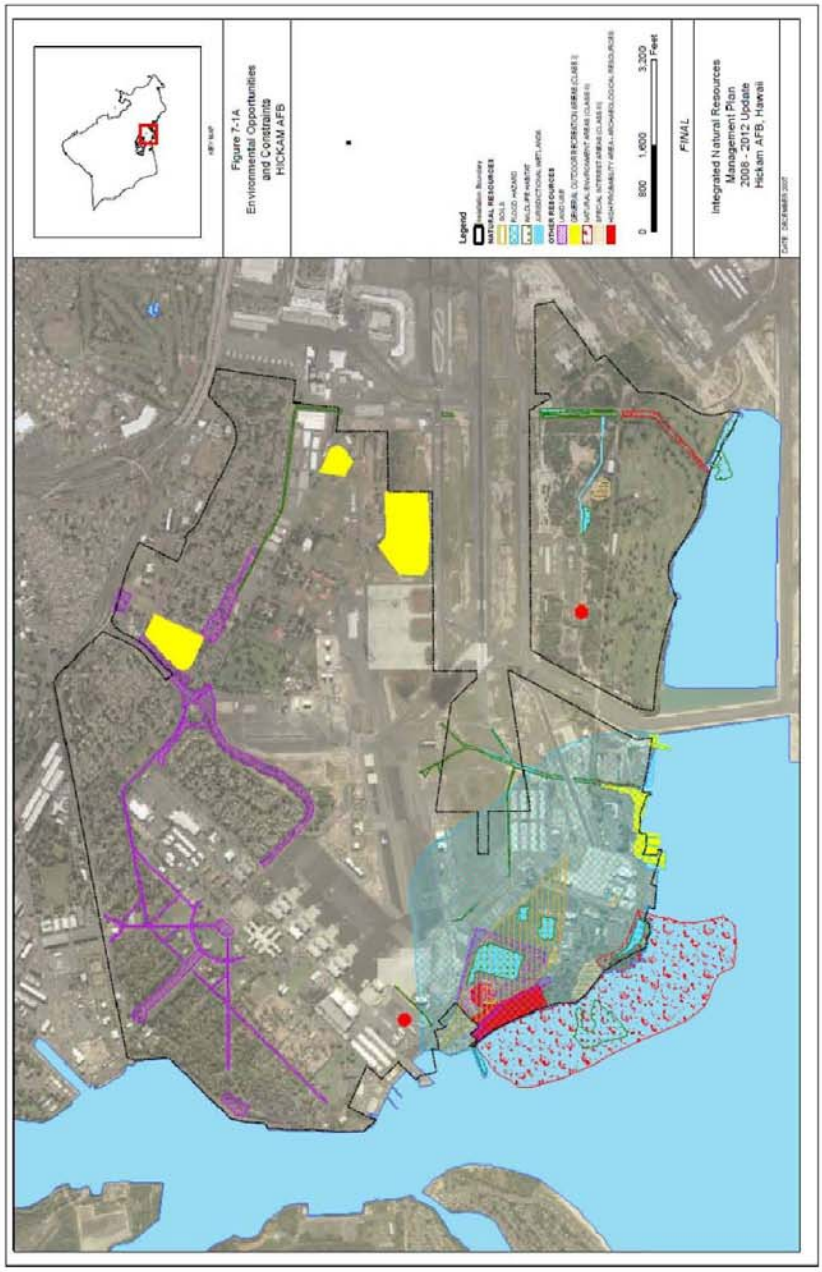
The small intertidal sand islands found on Ahua Reef in the vicinity of the wetland reserve area include foraging and potential nesting habitat for the endangered black-necked stilt (*Himantopus mexicanus knudensi*). The high level of human activity in the area, combined with easy access by predators (cats), currently renders the site unsuitable for nesting.

Opportunity: Reductions in human activity combined with effective predator control could make the islands an opportunity for habitat enhancement. Implement the Exotic Predator Control Project (Section 10.2.2.2) and the Black-necked Stilt Radiotracking Project (Section 10.2.2.6) in order to enhance habitat on the islands.

Ephemeral ponds are low-lying, seasonally ponded areas that have not been mapped because of their sporadic occurrence.

TABLE 7.1-1 ENVIRONMENTAL OPPORTUNITIES AND CONSTRAINTS FOR HICKAM AFB, OAHU, HAWAII

Resource	Data Category	Opportunity	Constraint
Soils	JaC	None	Soil type requires special treatment and design considerations.
Hydrography	Open drainage	Opportunities for possible non-profit source pollution control and cleanup and for the preservation and enhancement of wetlands and riparian zones.	Enhancement of riparian zone for birds in some areas may be constrained by the base mission, which requires minimization of potential BASH problems.
	Stream	Provides wildlife habitat.	None
Flood Hazard	Zone A	None	Potential constraint to new facilities.
Wildlife Habitat	Wetlands	Important habitat for native and RTE species. Suitable forage for shorebirds and wading birds.	Potential BASH problem if enhanced.
	Sandflats	Important habitat for native and RTE species. Suitable forage for shorebirds and wading birds.	Potential BASH problem if enhanced. Requires predator control and restricted access.
Jurisdictional Wetlands	All	Support for and protection of wildlife habitat.	Extent of development, recreation, and training activities limited by requirement for Section 404 permit.
Offshore Reef	Shallow reef flat	Foraging opportunities for wading birds. Recreational opportunities for fishing, aquarium fish collection, nature watching and marine educational classes.	None
	Reef slope	Preservation and enhancement of habitat for marine fish, invertebrates, and mammals. Provides for recreational and educational opportunities.	None
	Sand and silt, subtidal	Foraging habitat for marine flatfish and invertebrates.	None
	Sand and silt, intertidal	Foraging habitat for wading birds.	None
Land Use	Open space	Preservation of resources (e.g., wetlands). Potential for conversion of part of Prime BEEF area to open space for habitat.	None
Outdoor Recreation	General (Class I)	None	Recreational development precludes use of the harbor and other areas for industrial activities.
	Natural (Class II)	Dispersed recreation activities (e.g., fishing, exploring of marine life, jogging, riding, etc.) promote environmental education.	Recreation activity may preclude use of areas for training or other mission- related activities.
	Special (Class III)	Interpretive tour of high value wetland reserve at Fort Kamehameha shoreline.	Recreation activity may preclude use of shoreline for training or other mission-related activities.
Cultural	Archaeological resource high probability area	Potential limitations on development provide potential for open space (including resource preservation).	The high probability for subsurface Native Hawaiian archaeological resource may result in limitations on construction.



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Constraint: Ephemeral ponds provide foraging opportunities for a variety of shorebirds and wading birds, including golden plovers and the federally endangered black-necked stilt. Use of the ponds by cattle egrets (*Bubulcus ibis*), a problem bird for BASH control, means the ponds need to be eliminated as much as possible. Therefore, implement the *Bird/Wildlife Aircraft Strike Hazard Plan* (15 AW 2005) (see Appendix O).

7.1.1.6 Jurisdictional Wetlands

Wetlands on federal lands are protected primarily under Section 404 of the Federal Water Pollution Control Act (Clean Water Act, P.L. 92-500, as amended). Final determination of jurisdictional status is the responsibility of the USACOE and is typically done on a project specific basis.

Opportunity: Jurisdictional wetlands provide opportunities for wildlife habitat, as discussed above.

Constraint: Jurisdictional wetlands also constitute constraints on development, recreation, and training activities that would result in alteration, destruction, loss, or degradation of the wetlands. Therefore, implement the following projects: Section 404 Permit - Training in Wetlands (Section 10.3.2.1); Permanent Wetland Database (Section 10.3.2.2); and Long-term Monitoring of Wetland Functions (Section 10.3.2.3).

7.1.1.7 Offshore Reef

All of the reef categories were included on the composite map as offshore reef, although the reef slope contains the highest abundance and diversity of fish and invertebrate fauna. Adult and juvenile green sea turtles (*Chelonia mydas*) were observed near the reef, including one large individual resting in a small cave at the Pearl Harbor entrance channel. The reef habitat has been adversely affected by sedimentation from onshore (canals) and offshore (dredging) sources, and it may be impacted by high nutrient input and pollution from military and urban activities.

Opportunity: Ahua Reef provides an opportunity for preservation and enhancement of habitat for marine fish, invertebrates, and mammals. Therefore, implement the Ahua Reef Cleanup Project (Section 10.10.2.2) and the Watercourse Sediment Removal Feasibility Study Project (Section 10.4.2.1).

Opportunity: The accumulated sand and silt in intertidal areas provide foraging opportunities for wading birds and are thus habitats of value to other wildlife resources. Implement the Exotic Predator Control Project (Section 10.2.2.2) to protect wildlife.

7.1.1.8 Land Use Opportunity

The reef provides a recreational opportunity for fishing, aquarium fish collection, and nature watching. The reef has a history of utilization for marine education classes for local youth. In order to optimize this opportunity, implement the Natural Resources Web Page Project (Section 10.2.2.4) and the Shoreline Access/Interpretive Trails Project (Section 10.8.2.2).

Constraint: There is a potential conflict between human recreational use of the reef and enhancement of the reef as habitat for marine vertebrates and invertebrates. Recreational use has resulted in the removal of animals and damage to corals (from fishing anchors and lures and from walking in shallow areas). Therefore, implement the Shoreline Access/Interpretive Trails Project (Section 10.8.2.2), the Boat BMP Signs Project (Section 10.10.2.1), and the Ahua Reef Cleanup Project (Section 10.10.2.2).

Existing and future land uses from the Base General Plan (BGP) that accommodate resource opportunities for this INRMP are "open space" and "outdoor recreation." Significant open space areas include a landscaped central mall area and an unmanaged vegetation area behind the housing area at Fort Kamehameha. Only open space is shown on the composite map, because outdoor recreation is shown as depicted on the separate Outdoor Recreation Plan map. The BGP's outdoor recreation areas are primarily Hickam Harbor and the 18-hole golf course. These and other areas (excluding the golf course) have been identified in the *Outdoor Recreation Plan* (15 ABW 1995b).

Opportunity: The open space designation provides an opportunity for preservation of resources in several locations, including the large wetland area at Fort Kamehameha. Therefore, implement the Wetland Enhancement at Fort Kamehameha Project (Section 10.3.2.4).

Constraint: Other low value wetland areas are located where the land use designation is Light Industrial, and permitted activities include military training and the storage of explosive materials. Wetland resource areas do not conflict with the explosives safety plan, but may be incompatible with areas used for intensive training (north of the golf course). Therefore, implement the Section 404 Permit - Training in Wetlands (Section 10.3.2.1) and the Revegetation: Ammunition Storage/Training Area (Section 10.6.2.9) projects.

Opportunity: If the "Prime BEEF" training area is relocated to Bellows AFS, there may be an opportunity to convert part of this industrial area to open space and improve the area for wildlife habitat.

7.1.1.9 Outdoor Recreation

Outdoor recreation opportunities identified in the *Outdoor Recreation Plan* (15 ABW 1995b) are shown on the composite map for their potential to provide opportunities for public enjoyment of natural resources and for evaluation of potential incompatibilities with natural resources and habitat values.

General Outdoor Recreation (Class I): *Areas utilized for intensive recreational activities.*

General Outdoor Recreation (Class 1) areas are utilized for "...intensive recreational activities, such as camping, winter sports, and water sports, and those areas which are managed for intensive recreational use" (15 ABW 1995b). The recreation opportunity areas that pose potential conflicts are located at Honeymoon Beach and Hickam Harbor. Dredging activity at the harbor, which is needed to maintain access, affects the reef habitat and results in the potential for hazardous material spills. Activities at beaches and near wetlands can disturb some wildlife species, but the disturbance is not expected to be severe.

Constraint: Commitment to intensive outdoor recreation precludes use of these areas for other mission activities. Therefore, implement the Harbor Park Enhancement Project (Section 10.8.2.4).

The golf courses are not Class I facilities, so they are not shown on the composite map. The lower Manuwai Canal traverses the golf course. The golf course, with its controlled access, acts as a buffer to the canal and wetland area at the mouth of the canal near the Reef Runway Lagoon, a resource opportunity. However, golf balls litter the wetland area.

Natural Environmental Areas (Class II): *Those places capable of supporting dispersed recreational activities.*

Natural Environmental Areas (Class II) are those places capable of supporting dispersed recreational activities, such as hunting, fishing, birdwatching, driving and walking for pleasure, sightseeing, jogging, climbing, and riding (15 ABW 1995b). At Hickam AFB, exploring for marine life on the shelf of the reef at the Fort Kamehameha shoreline is a Class II activity. Here youth are given an opportunity to collect marine life, study it, and then return it to the ocean. These educational opportunities for local youth may be incompatible with the health of the coral reef, unless walking routes are carefully chosen and followed. Fishing is not allowed in either Kumumau'u Canal or Manuwai Canal, because of human health risk from hazardous materials.

Opportunity: Dispersed recreation provides opportunity for environmental education. Implement the Recreation and Environmental Education Needs Assessment Project (Section 10.8.2.1), the Shoreline Access/Interpretive Trails Project (Section 10.8.2.2), the Bird Watching Guide Project (Section 10.8.2.3), and the Natural Resources Web Page Project (Section 10.2.2.4).

Constraint: Recreation activity throughout the week may preclude use of areas for training or other mission- related activities. Reductions in recreation activity are not recommended in this INRMP (see projects listed above).

Special Interest Areas (Class III): *Areas with valuable archaeological, botanical, ecological, geological, zoological, scenic or similar features.*

Special Interest Areas (Class III) are areas with valuable archaeological, botanical, ecological, geological, zoological, scenic, or similar features. The Outdoor Recreation Plan proposes an interpretive tour of the natural wetland features of the Fort Kamehameha shoreline, including facilities such as interpretive signs and an established trail (15 ABW 1995).

Opportunity: This high value wetland provides an opportunity for environmental education that needs to be implemented very carefully so that habitat values are preserved. Implement the Shoreline Access/ Interpretive Trails Project (Section 10.8.2.2).

Constraint: Recreation activity combined with resource values may preclude use of shoreline for training or other mission-related uses. Reduction in recreation activity is not recommended in this INRMP (see Section 10.8.2.2).

7.1.1.10 Cultural

Hickam AFB is an historic district containing several buildings from the 1930s and 1940s. The Fort Kamehameha historic district contains buildings from the early 1900s. Their presence may limit mission activities, which could affect the structures. A portion of the base also has a high probability of containing Native Hawaiian archaeological resources. An *Integrated Cultural Resources Management Plan* (ICRMP) for Hickam AFB (15 AW 2007) has been developed and provides guidelines and standard operating procedures to non-

technical managers, planners and user groups, in promoting the Air Force's legal responsibilities for the preservation of significant archeological (prehistoric) and historic cultural resources at Hickam AFB.

Opportunity: The high-probability archaeological areas would support natural resource preservation through cultural resources management policies that may result in limiting construction activity.

Constraint: Cultural resources that may be threatened by future base operations have been identified in the 2007 Hickam AFB ICRMP. This ICRMP also identifies the relevant ICRMP program to be followed for treatment of these threatened and/or unanticipated cultural resources.

7.1.2 Land Uses and Military Mission

Land use issues at Hickam AFB relate primarily to conflicts between wildlife needs and military mission activities. Turf and other areas near active runways need to be maintained to minimize bird/wildlife aircraft strike hazard (BASH). Therefore, implement the BASH Plan (15 AW 2005) and the Landscape Development Master Plan Project (Section 10.6.2.6).

Shoreline areas contain important habitat and reef areas that are used for recreation. Potential conflicts between these human and habitat needs are to be resolved (as discussed in Chapters 9 and 10), in particular by implementing the Shoreline Access/Interpretive Trails Project (Section 10.8.2.2), and the Ahua Reef Cleanup Project (Section 10.10.2.2).

7.1.3 Threatened and Endangered Species and Critical Habitats

There is an extremely low probability that any rare, threatened, and endangered (RTE) plant species occur on Hickam AFB, and there are no immediate concerns related to RTE plant species.
Issues identified below with regard to shorebird habitat and impacts of human activities (Fish and Wildlife Management Section 7.1.6) are also pertinent to the black-necked stilt, a federally endangered bird species that utilizes Hickam AFB. Bird-aircraft strike records at Hickam AFB indicate that at least one black-necked stilt has been killed by commercial aircraft in the vicinity of the runways; therefore, implement the Black-necked Stilt Radiotracking Project (Section 10.2.2.6), the Incidental Take Permit Project (Section 10.2.2.1), and the practices of the BASH Plan (Appendix O).

Green sea turtles, a listed species, frequent the reef south of Hickam AFB. Although less common, Hawaiian monk seals and humpback whales may also visit nearshore areas. The reef offshore of Hickam AFB may benefit from more protection than is now in place. Therefore, implement the Ahua Reef Cleanup Project (Section 10.10.2.2).

The pueo or short-eared owl (Asio flammeus sandwichensis), a Hawaii State Endangered species, has been observed on Hickam AFB (found under a truck), but it is not thought to nest there. As a result, its management as a resident species is not an issue. However, the potential exists for the pueo or other RTE birds to be found on the base, and management procedures for rescue of injured birds are needed. Therefore, implement the Monitoring Surveys Project (Section 10.2.2.5).

7.1.4 Wetlands

Jurisdictional wetlands were identified in three areas on Hickam AFB: along the shoreline in the southern portion of Fort Kamehameha, inland from the shoreline on Fort Kamehameha, and along several canals and ditches. These wetlands are protected by Section 404 of the Clean Water Act, and a Section 404 permit would be required if these wetlands were to be filled as part of any base activity. Therefore, implement the following projects: Section 404 Permit - Training in Wetlands (Section 10.3.2.1) and Permanent Wetlands Database (Section 10.3.2.3).

A number of foot trails have been worn through the wetland along the marine shoreline southeast of Fort Kamehameha. Unofficial trails through wetlands result in trampling of vegetation and an increased risk of erosion. Since foot access is intended for this area, an educational program including signage is needed to keep people to the official trail only, or a boardwalk to the beach should be built. See the Shoreline Access/Interpretive Trails Project (Section 10.8.2.2).

A wetland occurring in a drainage ditch within the Prime BEEF training area may be negatively impacted by training activities. A Section 404 permit may be required by the U.S. Army Corps of Engineers (USACOE). To resolve this issue, see Section 10.3.2.1.

Wetlands occurring on the salt flats in the low-lying areas of Fort Kamehameha are disturbed, low value wetlands with sparse vegetation. Although they have little natural resource value, they may create constraints on use of this land for buildings or other land uses. Options for natural vegetation improvement that would not interfere with their jurisdictional wetland status or adversely impact the mission are addressed in this INRMP, Section 10.3.2.4, the Wetland Enhancement at Fort Kamehameha Project. (Note that, due to the proximity of this wetland to the approaches to Runway 8L, any wetland enhancement plan must include options/actions for discouraging wetland birds from using the area, in order to minimize the potential for bird strikes. USFWS should be consulted for appropriate actions.)

7.1.5 Watershed Protection

Hickam AFB has no natural streams within its lands, and it is situated on flat lands along the marine shoreline. As such, issues of concern include by the stormwater canals. These issues are resolved by implementing the following: BMPs for Water Quality Protection (Appendix F), Hawaii's Non-Point Source Water Pollution Management Plan (Appendix F), and Erosion and Sediment Control BMPs (Appendix F).

7.1.6 Fish and Wildlife Management

Endemic gobies are found in low numbers within the canals. Although they are not currently protected by law, their populations are reduced from historic levels at many places in Hawaii. Many introduced freshwater species are found in the canals, which may compete with, or forage on, native species. Therefore, implement the Exotic Fish Eradication Project (Section 10.5.2.8).

Poor water quality due to hazardous materials, garbage and litter, low water flows, and low dissolved oxygen reduces aquatic habitat value in the canals on Hickam AFB. Excessive sedimentation also negatively affects aquatic habitat in the canals. Sediments are deep, anoxic and probably contain toxic

materials. Canals are gradually being filled in. Therefore, implement the Watercourse Sediment Removal Feasibility Study Project (Section 10.4.2.1).

There is native shorebird and waterbird habitat in the wetland reserve southeast of Fort Kamehameha in the Reef Runway Lagoon area. Impacts from development or high intensity recreation use could affect use of this habitat by wildlife. Therefore, implement the Exotic Predator Control Project (Section 10.2.2.2), the Shoreline Access/Interpretive Trails Project (Section 10.8.2.2), and the Ahua Reef Cleanup Project (Section 10.10.2.2).

Predators (e.g., dogs, cats, mongoose, rats) are present on Hickam AFB and are very detrimental to birds, particularly around wetlands. Control of predator populations is desirable for reducing mortality of native birds using Hickam AFB. See Section 10.2.2.2, Exotic Predator Control Project.

Brown tree snakes can be introduced to Hickam AFB from aircraft or offloaded cargo. These snakes are a very serious threat to native wildlife, and their control is an important concern. See Section 10.2.2.2.

The relatively high level of human activity negatively impacts native birds using available habitat on Hickam AFB. Educational programs for Hickam AFB residents and personnel regarding native fauna and habitat would be valuable for reducing these impacts. Therefore, implement the Bird Watching Guide Project (Section 10.8.2.5), and the Natural Resources Web Page Project (Section 10.2.2.4).

Native birds, particularly the golden plover, utilize turf areas on Hickam AFB. Maintaining grass height below 6 inches in these turf areas would provide the most usable habitat for these birds. However, BASH control for cattle egret is required in runway areas. Land management to either encourage or discourage these and other birds is an issue, which is subject to practices described in the BASH control plan (15 AW 2005).

7.1.7 Grounds Maintenance

Hickam AFB has extensive landscaped areas, many of which complement historic areas and are important to the overall aesthetic value of the base. There is an ongoing need to maintain high quality landscaping and intensive grounds maintenance, yet there are also concerns about inefficient use of irrigation and labor. Water conservation is a major concern in Honolulu and surrounding areas. Conversion of landscaping in some non-historic areas to low water/low maintenance plants is addressed in this INRMP, Section 10.6.2.6, Landscape Development Master Plan. Also, managed trees on base are to be inventoried (Section 10.6.2.2) and an Urban Forestry Management Plan (Section 10.6.2.9) is to be prepared.

Meeting criteria for Tree City USA designation is a directive specified in draft AFI 32-7064 (Section 11.5.2). Hickam AFB has not yet applied for Tree City USA designation, but does expect to receive the designation within the next year. This is addressed in this INRMP, Section 10.6.2.7.

Pest control (birds, insects, and weedy plants) is a minor problem in landscaped areas. Current insect pest problems include blister mites, and plant pest problems include mangrove. Control of these pests is primarily through manual methods, and is addressed in the *Pest Management Plan* (15

AW 2007) (Appendix P), Landscape Development Master Plan Project (Section 10.6.2.6) and the Reorganization/Training for Grounds Shop Project (Section 10.6.2.4).

The lack of native plant species at Hickam AFB is a concern. Native plant species that could be used in restoring or landscaping sites is addressed in this INRMP, Section 10.9.1, Outleasing for Native Plant Horticulture Project.

7.1.8 Commercial Forestry

No commercial forestry occurs on Hickam AFB, and it is not an issue because the establishment of commercial forests is not practical on this highly urbanized base.

Collection of seeds from planted trees in landscaped areas is reported to occur. A plan for making this resource available to the public, while protecting the health of the trees, is addressed in this INRMP, Section 10.7.2.1, the Urban Tree and Plant Seed Harvest Project. This is a potential source of revenue to offset costs of project administration.

7.1.9 Outdoor Recreation and Public Access

An Outdoor Recreation Plan for Hickam AFB has been completed, and it makes a number of recreation management recommendations. The Plan indicates that recreation facilities could be expanded and improved to meet current and future needs. How and when to implement these recommendations is an issue, and they need to be evaluated based on identified natural resources and potential conflicts. Implement the Recreation and Environmental Education Needs Assessment Project (Section 10.8.2.1) and the Trail Impact Monitoring and Maintenance Program Project (Section 10.8.2.10).

7.1.10 Agricultural Outleasing

No agricultural outleasing is conducted on Hickam AFB. Potential locations for a native plant nursery that could be outleased are identified in this INRMP through the Outleasing for Native Plant Horticulture Project (Section 10.9.2.1).

7.1.11 Coastal Issues

The reef off of Hickam AFB currently has a high rate of fishing effort for food-fish. This high effort may be higher than the reef can sustain. "Ghost" fishing gear, including monofilament gill nets, are present on the reef. To resolve this, implement the Ahua Reef Cleanup Project (Section 10.10.2.2) and the Natural Resources Web Page Project (Section 10.2.2.4).

The reef may have increased rates of sedimentation due to dredging of channels providing access to Pearl Harbor and Hickam Harbor. Therefore, implement the Watercourse Sediment Removal Feasibility Study Project (Section 10.4.2.1).

Pollution from canals, including pesticides, fertilizers, fine sediments, and hazardous materials, may be impacting algal growth rates and reef health. Implement the Watercourse Sediment Removal Feasibility Study Project

(Section 10.4.2.1) and Hawaii's Non-Point Source Water Pollution Management Plan (Appendix F) in order to improve reef health.

7.1.12 GeoBase

The natural resource inventories include a GeoBase of base resources. At issue is the availability of 15 CES personnel adequately trained to use and maintain this database over time. Therefore, implement the GeoBase Accessibility Project (Section 10.11.2.1), the Integration with Other Databases and CADD Project (Section 10.11.2.2), and the Maintain/Update Natural Resource Data Layers Project (Section 10.11.2.4).Created entities will be within the proper SDS Geodatabase files, which can be reviewed by the current ESRI GIS product, ArcMap 9.1.

7.3 HICKAM POL PIPELINE

The following issues pertain to the two fuel storage annexes (Waikakalaua and Kipapa FSAs), because these are the areas owned and actively managed by the Air Force. The pipeline extends over public and private lands on which the Air Force has an easement or right-of-way but does not actively manage.

The open space status of the fuel storage annexes provides an opportunity for enhancement of their limited wetland and wildlife values. There is also soil suitable for a native plant nursery.

7.3.1 Natural Resources Opportunities and Constraints

The Hickam POL Pipeline system's two fuel storage annexes are mapped separately. The following sections discuss the resource opportunities available and their constraints to the military mission for each FSA.

7.3.1.1 Kipapa FSA

Resource opportunities and constraints are shown in composite form in Figure 7-3a and are listed in Table 7.3-1.

SOILS

Two soil types dominate the Kipapa FSA installation: Haleiwa silty clay, 0-2 percent slopes (HeA) and Helemono silty clay, 30-90 percent slopes (HLMG).

Opportunity: The Haleiwa silty clay on the floor of Kipapa Gulch has a capability classification that supports agricultural use, such as a nursery for propagation of native plants. Implement the Outleasing for Native Plant Horticulture Project (Section 10.9.2.1).

Constraint: The Helemono silty clay erosion potential, as well as the steep slopes on which this soil occurs, are a constraint to development in the area. Limit on-site erosion from any construction activity (Appendix F).

A minor component of the area's soils is Manana silty clay, 1-25 percent slopes (MPD), which has a moderate erosion risk. Only a small portion of the installation on the upland area above the tunnels contains this soil type, but its characteristics should be considered if any ground-disturbing activities are planned in this area. Implement Erosion and Sediment Control BMPs (Appendix F).

Kipapa Stream is a natural streambed that exists in an unmanaged condition.

HYDROGRAPHY

Kipapa Stream is a natural streambed going through the installation that exists in a relatively unmanaged condition. Preservation of the stream and its riparian zone provides a resource opportunity to enhance wildlife and aquatic species. Although no floodplain mapping is available, flash floods are known to occur in the gulch. Consequently, the stream's floodplain could be a constraint to future development in the area. Kipapa Stream is currently diked on the installation to prevent flooding of the FSA. Since the FSA is now inoperative, opening up the stream to more of its natural floodplain is an opportunity to enhance wetland and wildlife resources as well as to allow retention of floodwaters to reduce effects downstream. However, any alterations to the dike by the Air Force would need to be cleared with the Judge Advocate.

The composite map also shows a diversion canal at the eastern edge of the installation that handles off-base water.

Opportunity: Preservation of Kipapa Stream and its riparian zone provides a resource opportunity to enhance wildlife and aquatic species. Removal of the dike should be investigated because it would allow retention of floodwaters and enhance the wetland. For this INRMP, implement the Long-term Monitoring of Wetland Functions Project (Section 10.3.2.3).

Constraint: Kipapa Stream's floodplain is a constraint to future development in the area. If development is proposed, then the floodplain would need to be mapped. This INRMP does not include a floodplain identification project for the 2008-2012 time frame.

WILDLIFE HABITAT

Habitat types that are present on the installation are second growth forest, shrubland, a grassland wetland, turf areas around the facilities, and stream habitat that could be used by shorebirds and native waterbirds. The primary opportunities for enhancement of wildlife habitat are along Kipapa Stream and in the small grassland wetland.

Although not mapped as an opportunity, turf areas are used by the Pacific golden plover, a migratory native bird.

Opportunity: Improving the riparian area, modifying the wetland, and possibly opening up the floodplain would all result in a net benefit to wildlife by providing more potential habitat for waterbirds. Implement the Long-term Monitoring of Wetland Functions Project (Section 10.3.2.3) and the Monitoring Surveys Project (Section 10.2.2.5).

JURISDICTIONAL WETLAND

The wetland present on the installation provides both a resource opportunity and a constraint. Although it is small and of low value, it may have been impacted by historic stream bank modifications that were made to prevent flooding of the installation.

Opportunity: The wetland would likely be enhanced by an increased occurrence of flooding in the historic floodplain. Enhance the wetland by

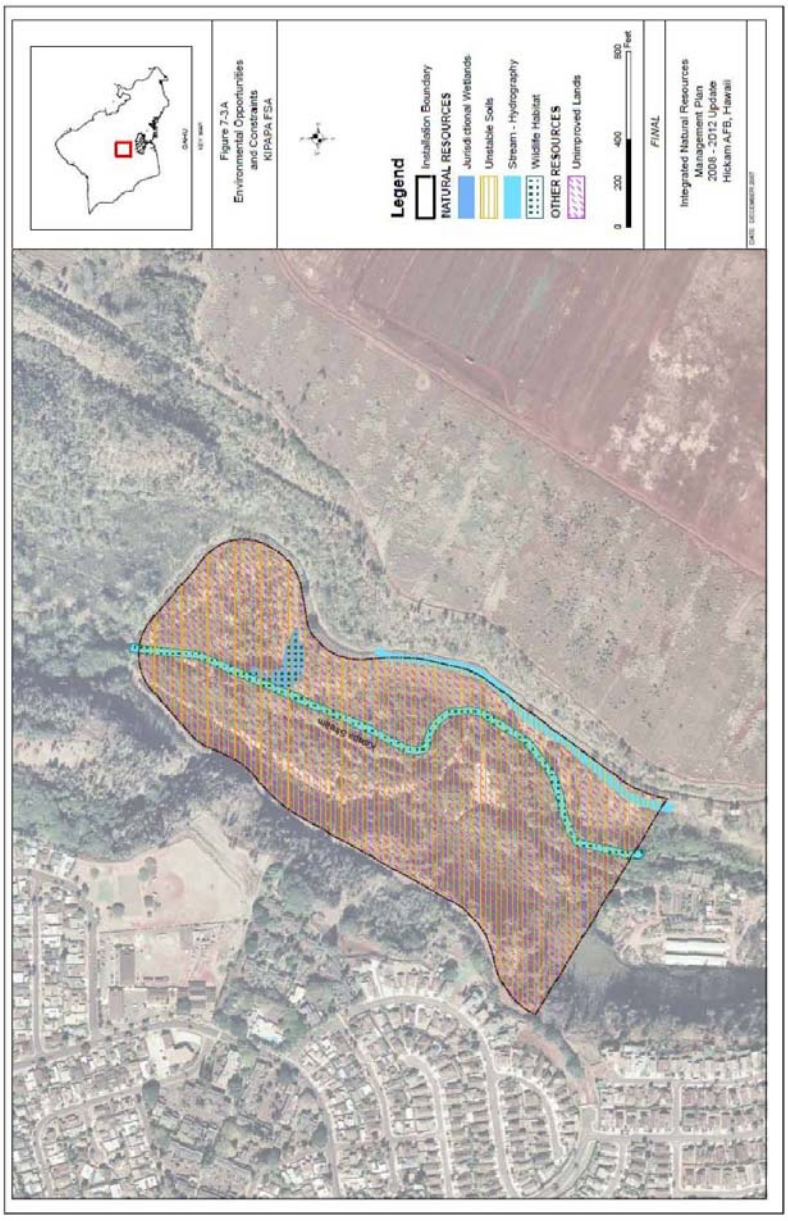

Figure 7-3a Environmental Opportunities and Constraints, Kipapa Fuel Storage Annex

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implementing the Long-term Monitoring of Wetland Functions Project (Section 10.3.2.3).

Constraint: Since it is a jurisdictional wetland, it is protected by law, and thus is a constraint to development. It is assigned to the Watercourse and Natural Resources Multiple Use MEAs for management protection.

LAND USE

Nearly all (over 99 percent) of the Kipapa FSA is identified as open space. Consequently, this use presents an opportunity to preserve the natural resources in the area.

TABLE 7.3-1 ENVIRONMENTAL OPPORTUNITIES AND CONSTRAINTS FOR **KIPAPA FSA, OAHU, HAWAII**

Resource Map	Data Category	Opportunity	Constraint
Soils	HLMG	None	Constraint to development because Helemono silty clay has severe to very severe potential for erosion.
	HeA	Supports agricultural use.	None
	MPD	None	Manana silty clay has moderate erosion risk that should be considered for ground-distributing activities.
Hydrography	Stream/canal	Enhancement of wildlife and aquatic species.	The stream's floodplain is a constraint to development.
Wildlife Habitat	Aquatic/riparian zone	Enhancement of habitat for shorebirds and native waterbirds.	None
Jurisdictional Wetlands	PEMIC	Opportunity to enhance the wetland if natural flooding is allowed to occur.	Constraint to development.
Land Use	Open Space	Preservation of the natural resources.	None

7.3.1.2 Waikakalaua FSA

Resource opportunities and constraints are limited at Waikakalaua FSA. They are listed in Table 7.3-2 and are shown on Figure 7-3b.

SOILS

Most of the soil at the Waikakalaua FSA is of the type WaA, Wahiawa silty clay, 0-3 percent slope, which has a slight erosion risk and is suitable for cultivation. Only about 11 percent of the acreage consists of Helemono silty clay, 3-90 percent slopes (HLMG) with a severe to very severe potential for erosion. Consequently, operational constraints to development on the site are minimal.

WILDLIFE HABITAT

Most of the Waikakalaua FSA consists of turf that provides habitat for a variety of land birds, including the endemic Pacific golden plover and several exotic species. These areas are not unique, so they are not shown on the composite map as a resource opportunity.

TABLE 7.3-2 ENVIRONMENTAL OPPORTUNITIES AND CONSTRAINTS FOR WAIKAKALAUA FSA, OAHU, HAWAII

Resource Map	Data Category	Opportunity	Constraint
Soils	HLMG	None	Constraint to development because of severe to very severe potential for erosion.
	WaA	Suitable for cultivation.	None
Land Use	Open Space	Opportunity for vegetation management around the installation perimeter.	None

LAND USE

All of the 28-acre Waikakalaua FSA is semi-improved for light industrial land use. The area surrounding the installation fenceline area is unimproved open space, which presents an opportunity for vegetation management around the installation perimeter.

7.3.2 Land Uses and Military Mission

There do not appear to be any existing on-site land use conflicts, so land use is not an issue at either Kipapa or Waikakalaua FSAs. However, Kipapa FSA borders a high-density residential area, and security and domestic/feral cats who prey on wildlife are issues. Maintain secure access and implement the Exotic Predator Control Project (Section 10.2.2.2) if RTE species are identified during implementation of the Monitoring Surveys Project (Section 10.2.2.5).

7.3.3 Threatened and Endangered Species and Critical Habitats

Kipapa Stream within the Kipapa FSA appears to have suitable habitat for federally endangered waterbirds, including Hawaiian duck (*Anas wyvilliana*), Hawaiian coot (*Fulica americana alav*), and common moorhen (*Gallinula chloropus sandvicensis*). Protection of aquatic habitat used by all of these species from on-base activity is presently not an issue, but it could become one if changes in current land use of the Kipapa FSA were to occur. Of concern is the potential for domestic and feral cats to prey upon RTE species. Implement the Monitoring Surveys Project (Section 10.2.2.5) and the Exotic Predator Control Project (Section 10.2.2.2).

There are no critical habitats at Waikakalaua FSA.

7.3.4 Wetlands

The only potential jurisdictional wetland identified on the Hickam POL Pipeline Fuel Storage Annexes is a small area within the unfenced portion of the Kipapa FSA. Although this wetland area would be regulated by Section 404 of the Clean Water Act, it is not a high value wetland. The regulatory protection of this wetland would be an issue if changes in land use at Kipapa FSA might result in the filling of this wetland. Implement the Permanent Wetland Database Project (Section 10.3.2.2) and the Long-term Monitoring of Wetland Functions Project (Section 10.3.2.3).

7.3.5 Watershed Protection

Waikakalaua FSA is located immediately above a major stream gulch, and Kipapa FSA is located within a stream gulch. Consequently, erosional or hydrological impacts stemming from activities at these facilities could affect downstream areas within their respective watersheds. Currently, there are no significant watershed issues from on-site activities at either site, but future land use changes would need to be evaluated with respect to watershed protection. Implement Hawaii's Non-Point Source Water Pollution Management Plan (Appendix F) and Erosion and Sediment Control BMPs (Appendix F) to protect downstream areas.

7.3.6 Fish and Wildlife Management

Kipapa Stream within the Kipapa FSA has the only aquatic habitat within the annex. A survey suggested this stream section was low in the abundance and diversity of aquatic species, but appears relatively free of past impacts to aquatic habitat. No specific management issues are apparent at present, but water quality and water flow concerns should be considered with any land use changes. There is no aquatic habitat at Waikakalaua FSA.
There are no wildlife issues at the Hickam POL Pipeline Fuel Storage Annexes other than those identified above under Section 7.3.3, Threatened and Endangered Species and Critical Habitats.

7.3.7 Grounds Maintenance

Infrequent grounds maintenance appears to be conducted at both the Kipapa and Waikakalaua FSAs. No specific management issues are apparent. Grounds maintenance requirements at Kipapa FSA would increase if a native plant nursery outlease is established at this site.

7.3.8 Commercial Forestry

No commercial forestry takes place at either of the Hickam POL Pipeline Fuel Storage Annexes. It is not an issue because Waikakalaua FSA has virtually no forested area, and Kipapa FSA is too small to support commercial activity.

7.3.9 Outdoor Recreation and Public Access

Neither of the Hickam POL Pipeline Fuel Storage Annexes has any outdoor recreation or public access. The potential for providing intensive recreation uses is small given the need for security and the presence of historic features.

7.3.10 Agricultural Outleasing

There is no agricultural outleasing at either of the Hickam POL Pipeline Fuel Storage Annexes. Although lands adjacent to Waikakalaua are in agricultural use, the buried tanks and aboveground piping limit agricultural use of the

installation. These structures would need to be removed if the site is considered for outleasing. A small site at Kipapa FSA has been identified as a potential outlease area for growing native plants. Implement the Agricultural Outleasing at Waikakalaua FSA Project (Section 10.9.2.2) and Outleasing for Native Plant Horticulture Project (Section 10.9.2.1).

7.3.11 Coastal Issues

Since the Hickam POL Pipeline Fuel Storage Annexes are inland sites, there are no coastal issues. See Section 7.3.5, Watershed Protection.

7.3.12 GeoBase

The natural resource inventories include a GeoBase of natural resources on both of the Hickam POL Pipeline Fuel Storage Annexes. At issue is the availability of 15 CES personnel adequately trained to use and maintain this database over time. Implement the GeoBase Accessibility Project (Section 10.11.2.1), the Integration with Other Databases and CADD Project (Section 10.11.2.2), and the Maintain/Update Resource Data Layers Project (Section 10.11.2.4).

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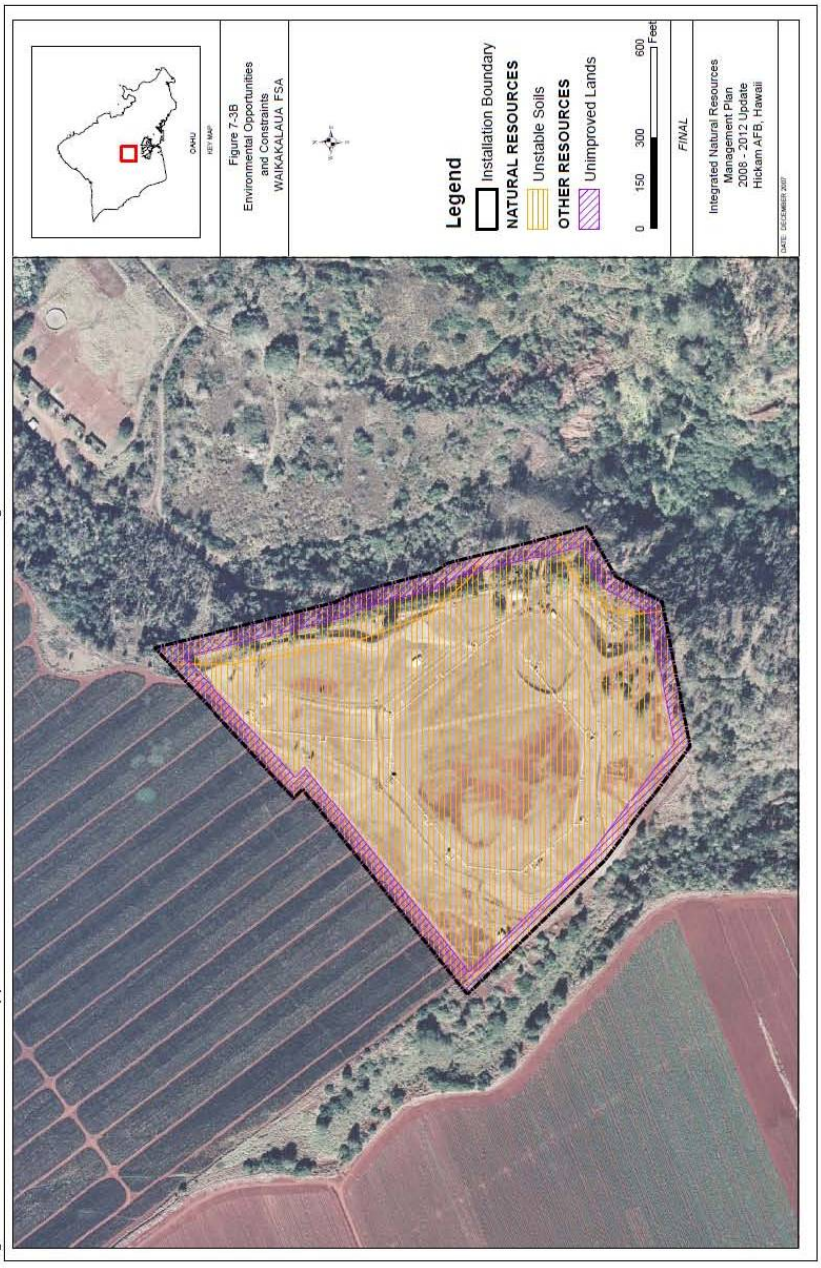

Figure 7-3b Environmental Opportunities and Constraints, Waikakalaua Fuel Storage Annex

9.1 GROUNDS, LAND USE, AND MANAGEMENT CATEGORIES

Natural resources management units include three categories (AFI 32-7064, Chapter 11):

1. Grounds categories of improved, semi-improved, and unimproved lands.
2. Land use categories that are subsets of the three grounds categories, i.e., the 12 categories in the BGP.
3. Land management units that are the smallest identifiable units used in developing natural resources management goals.

9.1.1 Grounds

Grounds categories are determined by the intensity of grounds maintenance necessary to maintain a neat appearance to the landscaping or to control for BASH. Grounds are discussed in detail in Chapter 6 in the sections describing vegetation, especially managed vegetation. The land use categories are classified according to the grounds categories for each installation in Chapter 5, land use classification sections. In summary:

- **Improved grounds** require intensive maintenance including mowing, irrigation, and landscaping. Land use categories that are usually associated with improved grounds are: housing (accompanied), housing (unaccompanied), community (service), community (commercial), medical, and administrative. Outdoor recreation and selected open space areas may be improved (heavily landscaped open areas including golf courses, parks, playgrounds, and athletic fields).
- **Semi-improved grounds** are those that require infrequent or unscheduled mowing and maintenance, and little or no irrigation. Land use categories that are usually associated with semi-improved grounds are: outdoor recreation (unimproved parks and picnic areas, open fields), light industrial, aircraft operations and maintenance, and airfield.
- **Unimproved grounds** do not require any maintenance except occasional brush control. Land use categories that are usually associated with unimproved grounds are light industrial (such as training areas at Hickam AFB), open space (such as wetlands), and water.

The turf map for Hickam AFB, Figure 6-1, shows grounds defined according to turf types. The Landscaped - High Maintenance areas correspond to improved grounds with the following turf types: golf, grove, roadside, general field, athletic field, residential, and industrial/commercial/administrative. Landscaped -Low Maintenance areas cover primarily airfield areas but also some industrial/commercial/administrative areas and general field, based on actual maintenance schedules. Areas without landscaping are areas without turf, such as the industrial area used for training and other areas with unmanaged vegetation (including wetlands).

9.1.2 Land Uses

The Hickam AFB BGP uses 12 basic land use types that are functional in nature. They are composed of activities that have a common general purpose. These types are summarized as follows.

Airfield: This use consists of the entire airfield pavement system (runway, taxiway, and apron), related open space, navigational aids, and all imaginary airfield and airspace clearance surfaces.

Aircraft Operations and Maintenance: This category comprises all facilities that directly support the flying mission, including all activities taking place on the airfield and in the hangars, shops, and terminals adjoining it.

Industrial: Industrial land use accommodates industrial facilities such as warehouses for various activities, base maintenance and utilities functions, and base industrial services such as those belonging to transportation, communications, and civil engineering. Included are ordnance and weapons storage, field training detachment, and the vehicle maintenance/motor pool complex.

Administrative: Administrative areas serve as the primary decision-making centers, and the category incorporates military command and tenant activity management, wing/group headquarters, and civilian administrative activities. These areas contain office activity with a higher density of workers than the industrial use. Other major administrative functions include indoor training and academic facilities.

Community (Commercial): This area covers the community center and commercial shopping, service, recreation, and day-to-day living needs of base personnel, their families, and military retirees within the area. At Hickam AFB, it corresponds to the site of the Base Exchange, the commissary, clubs, dining halls, personal services such as barber shops, and many indoor recreational facilities.

Community (Service): This category contains the noncommercial activities important in day-to-day living. It includes educational facilities, post office, library, childcare center, chapel, and religious education facilities.

Medical: This health care land use includes the hospital and/or clinics, the dental clinic, the BCE hospital maintenance shop, medical storage, and the veterinary care facility. The Red Cross may be sited here as well.

Housing (Accompanied): This is the family housing category. It consists of attached and detached residential units occupied by enlisted and officer families: family housing, temporary lodging facilities (TLF), TLF support, and mobile home parks.

Housing (Unaccompanied): This category is comprised of housing for bachelor officers, the airmen's dormitories, and visiting officer and airman's quarters.

Outdoor Recreation: There are three types of outdoor recreation spaces: neighborhood recreation areas such as "pocket" playgrounds and parks and picnic areas; low density outdoor recreation areas that require little or no

facility support and cause little land disturbance (picnic areas, parks, running tracks); and intensive use areas that serve large numbers of people and disturb land (golf courses, swimming pools, and tennis courts).

Open Space: These areas are undeveloped for the following reasons: buffer space between incompatible uses, undevelopable due to environmental or physical constraints, or required for safety or security clearances. Roadsides and airfield buffers are included.

Water: Open water includes ponds, major streams, and lakes on base, or shorefront areas along a river, large lake, or ocean. Water areas on the 15 AW installations are streams, canals, and the shorefront along the ocean.

9.1.3 Land Management Units

Land management units are the smallest identifiable land units used in developing the INRMP, according to AFI 32-7064. The original concept was that they correspond to a specific site, such as a wetland within an overall open space land use category. Land management units can be considered as individual land units or "polygons within the GeoBase" or as groups of land units to form Management Emphasis Areas (MEAs). The individual land units are identifiable in the GeoBase, and many are included on the environmental opportunities and constraints maps contained in Chapter 7. Land management to protect natural resources is accomplished in this INRMP with the MEAs which serve as an overlay to the land use plan. The MEAs represent the functional land management units for 15 AW installations covered in this INRMP. The following sections explain the MEAs and their applicability to the individual installations.

9.2 MANAGEMENT EMPHASIS AREAS

This Plan uses Management Emphasis Areas (MEAs) to focus and prioritize management efforts designed to achieve the specific goals and objectives presented in Chapter 8. Each type of MEA provides a management emphasis for a portion of an installation, where one or more uses dominate other uses. MEAs are geographic land units that have similar resource and management considerations. The use of these land management units will facilitate implementation of an effective integrated natural resources management program. Systematic implementation of the INRMP will continually improve compatibility between natural resources management goals and objectives and the installation mission.

Eight MEA categories were defined by integrating goals and objectives with the opportunities and constraints analysis and obtaining input from PACAF and 15 CES natural resources and civil engineering staff regarding existing mission-dependent development plans. Composite resource maps (Figures 7-1A to 7-8 in Chapter 7) developed during the opportunities and constraints analysis, along with outdoor recreation, turf, and base planning maps, were used to develop the geographic boundaries of the MEAs that were judged to best reflect the values of the resources in the area, existing and planned

recreational use, and mission requirements for facilities and training. The eight separate MEAs are:

- **Managed Natural Habitat (MNH):** Protected open space areas with native vegetation that requires active management to control non-native and pest species.
- **Natural Resources Multiple Use (NRMU):** Open space and water areas that support multiple use natural resources (e.g., outdoor recreation, fishing, wetland reserves, environmental education, specialized training).
- **Watercourse (W):** Waterway and open space along watercourses including a minimum 35-foot riparian zone buffer beyond the canal or stream banks.
- **Intensive Recreation (1R):** Class I outdoor recreation areas and other recreation areas with intensive use and supporting facilities.
- **Intensive Training (IT):** Undeveloped industrial land areas used for intensive training exercises involving large numbers of personnel and motor vehicles.
- **BASH Reduction (BR):** Airfield and aircraft operations areas, both paved and unpaved, that are managed to reduce the area's attractiveness to birds.
- **Landscaped - High Maintenance (LHM):** Landscaped areas that are intensively managed including historic and high visibility areas.
- **Landscaped - Low Maintenance (LLM):** Landscaped areas with a lower level of maintenance than LHM areas, often semi-improved with low maintenance turf and fewer ornamental trees and shrubs.

Table 9.2-1 summarizes which INRMP goals are implemented by each of the MEAs. For each MEA, one goal is a primary focus, but several other goals may also be supported by the management approaches prescribed. The resources database/GeoBase goal (Goal 11) is supported by all the MEAs, and it is omitted from the table.

TABLE 9.2-1 GOALS PROMOTED BY EACH MANAGEMENT EMPHASIS AREA (MEAs), 15 AW INSTALLATIONS

Goal	Managed Emphasis Area							
	Managed Natural Habitat	Natural Resources Multiple Use	Watercourse	Intensive Recreation	Intensive Training	BASH Reduction	Landscaped High Maintenance	Landscaped Low Maintenance
Land Uses and Military Mission		P		S	P	P		
Threatened and Endangered Species	P	S						
Wetlands	S	S						
Watershed Protection			P				S	S
Fish and Wildife Management	S	S	S					
Grounds Maintenance/Urban Forestry							P	P
Commercial Forestry							S	
Outdoor Recreation/ Public Access		S		P	S		S	
Agricultural Outleasing		S						
Coastal Resources		S	S				S	S
P = Primary focus; S = Secondary focus.								

Tables 9.2-2 and 9.2-3 summarize the fully compatible (F), conditionally compatible (C), and incompatible (I) land uses and recreation activities, respectively, for each MEA. Tables for each installation are provided separately in Section 9.3. Important activities and resources in each MEA are described in more detail in subsequent sections. It is important to keep in mind that particular types of activities are not necessarily exclusive within an MEA. For example, although BASH control is the primary concern in the BASH Reduction MEA, there is concern about BASH in all MEAs occurring near an active airfield. Table 9.2-2 presents the suitability of land uses for land categorized in each of the eight MEAs. All of these land use categories are used by 15 CES/CEVP on land use maps for the Base General Plan with the exception of training. Training was added as a separate category to distinguish

it from other light industrial uses. Table 9.2-3 indicates outdoor recreation activities and their compatibility with the eight MEAs.

TABLE 9.2-2 COMPATIBILITY OF LAND USES WITH MEAs, 15 AW INSTALLATIONS

Land Uses [1]	Managed Emphasis Area							
	Managed Natural Habitat	Natural Resources Multiple Use	Watercourse	Intensive Recreation	Intensive Training	BASH Reduction	Landscaped High Maintenance	Landscaped Low Maintenance
Airfield	I	I	I	I	C	F	I	I
Aircraft Operations and Maintenance	I	I	I	I	I	F	I	C
Runways, Taxiways	I	I	I	I	C	F	I	I
Light Industrial	I	I	I	I	I	I	F	F
Administrative	I	I	I	C	I	I	F	I
Community Commercial	I	I	I	C	I	I	F	I
Community - Service	I	I	I	C	I	I	F	I
Medical	I	I	I	I	I	I	F	I
Housing - Unaccompanied	I	I	I	I	I	I	F	C
Housing - Accompanied	I	I	I	I	I	I	F	C
Training	I	C	I	C	F	C	I	C
Outdoor Recreation	C	C	C	F	C	I	C	C
Open Space	F	F	F	F	F	F	I	F
Water	F	F	F	F	C	I	I	I
Agriculture	I	C	I	I	I	C	I	F

[1] = Modified from the Base General Plan, Hickam AFB.
F = Fully compatible.
I = Incompatible.
C = Conditionally compatible, subject to certain management requirements.

TABLE 9.2-3 COMPATIBILITY OF OUTDOOR RECREATION ACTIVITIES WITH MEAs, 15 AW INSTALLATIONS

Activity	Managed Emphasis Area							
	Natural Managed Habitat	Resources Natural Multiple Use	Watercourse	Intensive Recreation	Intensive Training	BASH Reduction	High Landscaped Maintenance	Low Landscaped Maintenance
Picnicking	I	C	I	F	I	I	C	C
Water Sports	I	C	I	F	I	I	I	I
Athletic Fields	I	I	I	F	I	I	I	I
Model Aircraft (Potential)	I	I	I	F	C	I	I	C
Golf	I	I	I	F	I	I	F	I
Hiking/Walking	C	F	C	F	C	I	F	F
Bicycle Use	I	C	I	F	C	I	F	F
Boating (Non-motorized)	I	C	C	F	I	I	I	I
Hunting	C	C	I	I	I	I	I	I
Fishing	I	C	C	C	C	I	I	I
Wildlife Watching	C	F	F	F	C	I	F	F
Nature Study (dispersed)	C	F	F	F	C	C	F	F
Archery (potential)	C	C	I	C	C	I	I	C

F = Fully compatible.
I = Incompatible.
C = Conditionally compatible, subject to certain management requirements.

The following sections describe each of the eight MEAs, and the land uses and recreation activities that are compatible or inconsistent with the MEA.

9.2.1 Managed Natural Habitat MEA

Preservation of existing natural resources and biodiversity is the primary objective of the MNH MEA.

Preservation of existing natural resources and biodiversity is the primary management emphasis for the Managed Natural Habitat (MNH) MEA. The MNH MEA is the most preservation-oriented of the eight MEAs and was developed primarily to address Goal 2 (Threatened and Endangered Species and Critical Habitat) described in Section 8.1. It also supports Goal 5 (Fish and Wildlife Management) by enhancing habitat available to wildlife species, and Goal 11 (Resources Database) by identifying highly sensitive areas where environmental management personnel need to focus and monitor habitat improvement efforts. The use of this category recognizes that any natural habitats found on installations in Hawaii must be managed to control the invasion of exotic species. At most installations, the habitat is primarily non-native, and the MNH MEA does not apply.

'Ohi'a wet forest at Kaala AFS

Managed Natural Habitat areas include relatively pristine areas within installation boundaries, such as the diverse mesic forest at Kokee AFS, which include flora and fauna that are predominantly native Hawaiian species. This MEA also includes areas at Kaala AFS targeted for rehabilitation to complement 'Ohi'a wet forest and bog areas within and surrounding the installation. The MNH MEA occurs only at Kaala AFS and Kokee AFS. Potential habitats for RTE (rare, threatened, or endangered) species are included primarily in this MEA, but some fall under the Natural Resources Multiple Use MEA.

Installation managers will have some discretion in determining the level of management activity within specific areas categorized as MNH-Management activity could range from monitoring for exotic plant species to intensive remediation aimed at improving wildlife habitat values or enhancing native/RTE species populations.

Any activity associated with or potentially impacting RTE species will be coordinated with USFWS. This is especially important if USFWS has designated "critical habitat" or established a species recovery plan. Specific management activities are described in Chapter 10, including:

- Monitoring for wildlife habitat (quantity and quality) and for the presence of RTE species would be accomplished at least every 5 years in the MNH MEA, although some specific areas may require more frequent monitoring to detect changes in resource conditions. No monitoring for RTE or wildlife habitat has been accomplished to date; however, annual monitoring for mongoose has been on-going for the past 4 years by the University of Hawaii.

- Management activities will include vegetation control (removal of exotics) and revegetation of barren areas. Progress should be monitored at least annually.

- Control of rodents and feral animal populations will be exercised selectively in cooperation with the DLNR, with technical assistance

from the Animal and Plant Health Inspection Service-Animal Damage Control (APHIS-ADC) of the U.S. Department of Agriculture (USDA) upon contract agreement.

The restriction of access and the very limited range of management activities proposed for this MEA are designed to create conditions favorable to maintaining and enhancing existing populations of native plants and animals and to protecting high value jurisdictional wetlands in a manner consistent with military missions and federal regulations.

Land Uses

The only land uses fully compatible with the MNH MEA are open space and water. Mission activities to maintain security of installation facilities/perimeter and to manage vegetation and wildlife are acceptable. Training activities and development of new facilities other than those relating to the installation fencing are incompatible with this MEA.

Outdoor Recreation

Hiking/walking, hunting, wildlife watching, and nature study are all recreational activities that are conditionally compatible with the goals and objectives of the MNH MEA (see Table 9.2-3). They are compatible on the condition that public access and use do not damage native plants or animals or federally-listed species. No intensive outdoor recreation (Class I) would be permitted in this area, due to the emphasis on biodiversity and preservation of native species. From a general policy perspective, environmental education and study (Class II and Class III outdoor recreation) will be allowed on a limited basis in the MNH MEA, to the extent that it is compatible with resource protection. However, from a practical standpoint the MNH MEAs identified in this INRMP are very small relative to lands adjacent to the installations, and the recreational and educational opportunities are more likely to be pursued in these adjacent areas. Similarly, the MEAs on the installations are too small for a substantial level of hunting activity, but hunters may be allowed access across unfenced portions of Kokee AFS, depending on the occurrence of hunting on adjacent state lands.

9.2.2 Natural Resources Multiple Use MEA

The NRMU MEA balances natural resource needs and human demands on the ecosystem.

Most open space (mainly unimproved) areas located in or near urban areas have been included in the Natural Resources Multiple Use (NRMU) MEA. This MEA was developed to balance natural resource needs, such as protection of wetlands and coral reefs, and human demands on the ecosystem (for development, training, and outdoor recreation). It addresses the following goals described in Section 8.1:

- Goal 1 - Land Uses and Military Mission (page 8-3)

- Goal 2 - Threatened and Endangered Species (page 8-4)
- Goal 3 - Wetlands (page 8-4)
- Goal 4 - Watershed Protection (page 8-5)
- Goal 5 - Fish and Wildlife Management (page 8-5)
- Goal 6 - Grounds Maintenance and Urban Forestry (page 8-6)
- Goal 7 - Commercial Forestry (page 8-7)
- Goal 8 - Outdoor Recreation and Public Access (page 8-7)
- Goal 9 - Agricultural Outleasing (page 8-7)
- Goal 10 - Coastal Resources (page 8-7)

The NRMU MEA recognizes that most of the installations are in ecosystems highly modified from their pristine condition. The vegetation in NRMU areas is dominated by exotic species (i.e., introduced, non-native species), but resource protection measures are needed to preserve certain habitat (and cultural) resource values. This may include control of exotic species that are potentially invasive into native vegetation.

Natural resources protection and enhancement is important in this MEA, but other mission-related uses are accommodated to a greater extent than in the MNH MEA.

For example, the NRMU MEA accommodates open space habitat such as wetlands, coral reefs, and turtle protection areas, along with mission-related activities, such as Class II outdoor recreation (environmental education), fishing, and limited training.

Land Uses

In the NRMU MEA, open space and water are compatible land uses. Offshore reefs at Hickam AFB and Bellows AFS are assigned to this MEA. All of the developed land uses are not compatible. Conditionally compatible uses are training and outdoor recreation, including amphibious assault exercises on portions of the reef at Bellows AFS. This MEA gives dispersed recreational use and non-intensive training (i.e., without on-land vehicular support) equal priority with natural resources preservation, depending on the specific activity and its location. Parcourses (exercise trails), exercise/obstacle courses, and similar dispersed outdoor recreation and training facilities will be permitted in this MEA (see Table 9.2-3) unless significant, unmitigatable adverse impacts on existing environmental conditions would preclude their use.

Outdoor Recreation

The Natural Resources Multiple Use MEA addresses the goal of providing outdoor recreation opportunities that promote the mental, physical, and social well-being of base personnel while minimizing adverse impacts from these activities on existing natural resources. The objective of minimizing impacts means that some constraints will be required on the type and intensity of the multiple use activities allowed in the MEA. More-intensive land management will be required to mitigate potential impacts on fish and wildlife populations and habitats, soil and water quality, and archaeological and historic resources.

In the NRMU MEA, other appropriate management activities related to recreation include expansion and maintenance of existing trail systems. Recreation use would be higher in this area than in the MNH MEA, resulting in the need for a greater frequency and intensity of trail maintenance, and also monitoring of habitat for signs of deterioration every 2-3 years. Temporary trail closures may be necessary during heavy precipitation or during specific wildlife breeding or migration seasons.

Most Class II recreation activities, such as hiking, jogging, and birding, and some Class 1 activities, such as boating, would be permitted in the NRMU MEA. Activities such as low-impact picnicking, water sports, fishing, hunting, and bicycle use are listed as conditionally compatible with the objectives of this MEA. No hunting will be permitted in these areas, because of their proximity to residential and other population centers, and because small installations do not provide sufficient land or meet security needs that would support hunting. Bicycle use will be allowed on hardened trails or maintained off-road trails.

Class III (special interest) recreation will also be permitted in the Natural Resources Multiple Use MEA, particularly access to areas for nature study and education. Walking, running, and biking trails could include educational signs or kiosks describing local ecological features and the plant and animal species occupying them. The NRMU MEA also includes Class III areas containing structures of historic importance at Hickam AFB and some subsurface archaeological resources at Bellows AFS. The latter shall be made known in general terms only to protect the resource in a manner consistent with the goals and objectives of the Cultural Resources Management Plan.

Development of new Class II/Class III recreation facilities and trails will be considered in the NRMU MEA. To address potential erosion problems, installation managers will consider surfacing for some trails. New trails will be designed to avoid impacts on wetlands: if it should prove necessary to traverse wetlands, raised structures (e.g., puncheon bridge) would be used. The Natural Resource Conservation Service (formerly Soil Conservation Service) standards for recreation facility construction will be used to minimize effects on soil and water resources.

Shoreline and marine areas such as the Ahua Reef near Hickam AFB are included in the NRMU MEA rather than the MNH MEA on the basis of their ongoing use for fishing or educational programs. Fishing is conditional on state regulations, while shoreline picnicking is compatible if it is low-impact and dispersed (no barbeques and large groups). Water sports such as scuba diving, snorkeling, surfing, and swimming are recreational activities compatible with the NRMU MEA. However, marine NRMU areas at Bellows AFS are also used for amphibious training activities, and water sport activities will not be allowed during these periods.

Hickam AFB Golf Course

Class I recreation, such as high-impact picnic areas for large groups and boat launch facilities would not be permitted in this MEA, but would be allowed in the Intensive Recreation MEA.

9.2.3 Watercourse MEA

The Watercourse MEA was developed to address Goal 4 (Watershed Protection) and Goal 5 (Fish and Wildlife Management) as described in Section 8.1 of this document. This MEA also supports Goal 10 (Coastal Resources) to the extent that sedimentation and pollution reaching the coastline can be reduced. The streams located at Kipapa FSA and Bellows AFS and the stormwater drainage canals at Hickam AFB are included in this MEA. Restoration and enhancement of water resources is the primary long-term management emphasis for this MEA.

Management activities are generally required throughout a drainage basin to achieve downstream goals and objectives for water quality and fish and wildlife habitat. Consequently, cooperation between the Air Force and other property owners within a basin is an important component of management in the Watercourse MEA. For this reason, success in achieving management goals and objectives for Kipapa FSA and Bellows AFS depend only in part on on-base activities. Cooperative agreements and Air Force participation in regional watershed plans are specific measures addressed in Chapter 10. In contrast, nearly all of the drainage basin for the canals on Hickam AFB lies within the base boundaries. Because activities in the Watercourse MEA may affect coastal waters, management activities which meet guidelines for the Coastal America Initiative (CAI), such as pollution control and habitat enhancement in estuarine waters, should be coordinated with and reported to CAI.

Watercourse management and water quality in general are additionally significant for Hickam AFB, as the Air Force is a signatory to the Pearl Harbor Estuary Agreement (Appendix E).

Land Uses

Open space and water are clearly compatible uses for the Watercourse MEA. All of the developed land uses and training are incompatible uses. Even though these uses are not located directly in this MEA, surface water runoff from these uses does enter the streams and canals. As a result, several management activities and restoration/enhancement projects are included in Chapter 10 and emphasized here.

The Watercourse MEA includes the watercourses and a recommended minimum 35-foot riparian zone buffer (Bay Pacific Consulting 1996) beyond the canal or stream banks. Small ditches tributary to the main canals on Hickam AFB were excluded from the buffering requirement. Management of buffer areas will emphasize improvement of water quality by reducing sediment, nutrients, and other nonpoint sources of pollution associated with grounds maintenance and pest control (e.g., fertilizers, herbicides, pesticides) in the buffer zone. This management objective will also apply in other MEAs that are adjacent to watercourses, especially the Landscaped - High Maintenance and Intensive Recreation MEAs.

Restoration efforts should focus on reducing the degree of channelization and increasing the level of channel complexity and riparian vegetation that provides shade and cover to aquatic animals, while respecting needs for BASH control and protection of archaeological resources and Native Hawaiian remains in specific areas at Hickam AFB and Bellows AFS.

BASH control is of concern in the lower portions of the two principal canals, Kumumau'u and Manuwai canals at Hickam AFB, from the edge of the airfield to the ocean. Channel complexity and riparian vegetation should not be improved in these reaches of the canals to minimize their attractiveness to birds, particularly herons and cattle egrets.

Archaeological resources and Native Hawaiian remains are likely to be present in the margins of Waimanalo Stream and Inoa'ole Stream at Bellows AFS and along the canals at Hickam AFB. Restoration activities that could affect these subsurfaces resources are dredging and any other ground-disturbing action. Dredging to remove accumulated sediments and the grubbing of roots (to remove mangroves or other vegetation) could affect resources that are regulated by 15 AW Integrated Cultural Resource Management Plans.

Restoration and enhancement of water resources is the primary management emphasis of the Watercourse MEA.

Restoration and enhancement of water resources is the primary long-term management emphasis for this MEA. Reducing sedimentation, maintaining or enhancing stormwater-conveyance capacity, and reducing pollution from past chemical spills are three specific management objectives (Section 8.2.4) that would contribute to enhancement of the watercourses in the short term. In addition, removal of invasive trees (e.g., mangrove/ironwood) and their replacement with native species would be a beneficial management action for the long-term stability of the watercourses, including controlling erosion and increasing habitat for native species.

- Management practices such as dredging of sediments, especially contaminated sediments, and removing selected vegetation are

acceptable when the long-term enhancement or restoration effect outweighs the short-term disturbance to the riparian ecosystem.

- Management of riparian zones (buffers) includes eliminating the practice of mowing grasses along canal or stream banks except in areas where BASH is a concern. Enhancement of riparian zones may include the planting of suitable trees to provide bank stability and shade.

Manuwai Canal at Hickam AFB

Outdoor Recreation

Outdoor recreation land uses are compatible on the conditions that (1) they do not adversely affect the watercourses, either directly or indirectly and (2) public access to the stream or canal and its aquatic resources does not pose an unacceptable risk to human health and safety, to the riparian ecosystem, and to protection of archaeological resources.

New Class I activities such as high impact picnicking are generally not allowed in the Watercourse MEA, but could be accommodated in an adjacent area if compatible with its management emphasis. The existing snack bar on the golf course may remain as long as litter is not allowed to blow into the canal. Class II activities such as fishing generally will be allowed in the watercourses, but use is subject to state fishing regulations and the human health risk, if any, associated with taking game fish from the specific water-course. Several watercourses on Hickam AFB are currently off limits to fishing due to pollution. Boating activities are compatible with the MEA, but only for non-motorized craft such as canoes or rafts. Hiking and walking within the buffer zone is allowed only on maintained trails designed to prevent stream bank degradation. Wildlife watching and nature study activities are compatible with the objectives of the MEA. No bicycling is allowed in the MEA, because trail degradation, which can lead to the introduction of sediments to the watercourse, is often much higher than that associated with hiking.

9.2.4 Intensive Recreation MEA

Support of outdoor recreation activities is the principal purpose of areas designated Intensive Recreation (IR) MEA. The goal of providing outdoor

recreation opportunities that promote the mental, physical, and social well-being of base personnel drives land management decisions for these areas. The Intensive Recreation MEA was developed primarily to address Goal 8 (Outdoor Recreation and Public Access) but also to address Goal 1 (Land Uses and Military Mission) described in Section 8.1.

The IR MEA includes existing Class I outdoor recreation *facilities and other areas with intensive recreation use.*

Land Uses

The Intensive Recreation MEA includes existing Class I outdoor recreation facilities, such as picnic and water sports areas. It also includes other recreation areas with intensive use, such as athletic fields and a driving range. Future development of intensive recreation facilities can and will occur next to existing facilities within the areas mapped for this MEA.

Intensive recreation sites are often in or near administrative, community--commercial, community-service, and housing areas at Hickam AFB and the short-term rental cottages at Bellows AFS, which facilitates access and promotes high levels of use of the facilities. The Intensive Recreation MEA allows recreation activities involving large numbers of users. Uses are generally highly concentrated and regulated. The numbers of recreation users are expected to be highest in this MEA. Training activity is conditionally compatible as long as it does not significantly limit use of the area by recreationists.

Airfield/light industrial, medical, and housing uses are not compatible with the Intensive Recreation MEA. Noise and traffic created by intensive outdoor recreation activities could disturb residents and employees, and public safety concerns will keep recreationists out of active airfield/aircraft operations areas.

Outdoor Recreation

This MEA is the most likely to provide sites for the development of new recreation facilities. All typical recreation management practices (e.g., landscaping, trail and facility maintenance) would apply to this area.

Beach at Hickam AFB

- Trails and other facilities in this area would generally be "hardened" (e.g., surfaced) to accommodate high levels of recreation use.

- Maintenance practices will prioritize measures to maintain and protect soil and water quality. In particular, nonpoint sources of pollution associated with grounds maintenance (e.g., erosion, garbage, herbicides, pesticides) will be carefully managed in this MEA, given the proximity of recreation areas to coastal resources.

Table 9.2-3 indicates the compatibility of outdoor recreation activities with all of the MEAs. As might be expected, nearly all activities are either compatible or conditionally compatible within the IR MEA. Only paintball games and hunting are incompatible with this MEA. Hunting is not allowed due to the small size of most installations or the proximity of population centers, and paintball games are considered similar to military training exercises in the level of expected natural resource impacts. Less-intensive outdoor recreation activities are acceptable uses in the Intensive Recreation MEA, although these may be better accommodated in other MEAs such as the Natural Resources Multiple Use MEA to take advantage of environmental education opportunities. Facilities associated with more dispersed recreation (e.g., hiking trails, interpretive nature boards or kiosks) are covered under the Natural Resources Multiple Use MEA.

9.2.5 Intensive Training MEA

The Intensive Training (IT) MEA addresses Goal 1 (Land Uses and Military Mission). It was developed because the level of some training activities is greater than that permitted in the NRMU MEA, and because off-road motor vehicles may be used extensively.

Land Uses

Training is the priority use in the IT MEA, including the use of off-road vehicles, and Class I outdoor recreation is a secondary use.

Most urban land uses are incompatible with the IT MEA. Airfield and related taxiways and runways are compatible as long as they are not in active use by aircraft. For example, the abandoned runways and taxiways at Bellows AFS are available for training use. Outdoor recreation and water uses are conditionally compatible. These uses need to be evaluated carefully to ensure that they do not seriously constrain training and that training would not degrade the recreation and water-based opportunities. Training and open space uses are compatible with the IT MEA.

Amphibious vehicles use the beach at Bellows AFS.

Although training is the primary activity in the IT MEA, Best Management Practices (BMPs) will be needed in order to minimize impacts of training or recreation on the natural resources. BMPs will be defined to reduce the risk of erosion (in Appendix F) and to minimize solid and hazardous wastes, in addition to protecting resources from adverse impacts. Some special areas within an IT MEA, such as small jurisdictional wetlands and archaeological sites, will be marked for restricted activity to preserve their natural features and meet federal environmental regulations.

Outdoor Recreation

While training is the priority use, the IT MEA also includes intensive Class I outdoor recreation as a conditional use and secondary management emphasis. Recreation and training activities can be partitioned in time rather than space, and are not incompatible for occupying a single MEA.

For example, intensive training occurs at the beaches at Bellows AFS during the week, and the public plays at these same beaches during the weekend. Most other recreation activities are compatible within this MEA as a secondary use to the principal activity of training. In particular, activities such as archery, model aircraft flying, and paintball may be pursued in the IT MEA at Bellows AFS during non-training periods.

9.2.6 BASH Reduction MEA

The BASH Reduction (BR) MEA addresses Goal 1 (Land Uses and Military Mission). It includes airfield and aircraft operations areas, including unpaved areas near the airfield at Hickam AFB, that require management specifically directed at reducing the area's attractiveness to birds.

Land Uses

Compatible land uses are primarily airfield runways and taxiways and the light industrial areas associated with aircraft operations and maintenance. Open space is also a compatible use. All other land uses are incompatible except for training. Training activity involving aircraft is compatible, but other training activities would likely be incompatible with the BASH Reduction MEA.

The BR MEA includes airfield and aircraft operations areas to be managed to control problem birds.

The principal birds of concern as an aircraft strike hazard are cattle egrets. Plovers and turnstones are not a problem except when they are migrating in a group. The plover hazard is high in September-October when juveniles arrive. Stilts and herons could be a problem if they fly across flight lines. Cattle egrets and shorebirds are attracted to sprinklers and ephemeral ponds, so areas near aircraft operations need to be well-drained. Specific land management activities (15 AW 2005) include:

- Maintaining a short, uniform grass height (7-10 inches), unless specified differently, in areas between taxiways, runway clear zones, and infields
- Controlling broad-leafed weeds
- Reducing edge effect (i.e., edges between different habitat types) by maintaining airfields as uniformly as possible
- Leveling airfields to prevent standing water

- Removing dead vegetation in clear zone areas
- Removing dead birds and other animals from the airfields
- Keeping drainage ditches clear and free of obstacles, including the removal of vegetation to maintain water flow and discourage use by birds
- Eliminating standing water to reduce attractiveness to birds.

The USFWS and USDA APHIS-Wildlife Services should also be consulted for appropriate habitat alteration actions to minimize take of bird species.

Another objective is to reduce, when practical, the maintenance costs associated with land management in BASH control areas. (See objective 6.4 in Section 8.2.) This objective can be met by converting any problem turf areas to vegetation less attractive to nuisance birds, by reducing the frequency or extent of mowing, or by controlling vegetation in drainage ditches on a regular basis. Nature studies planned in these areas (by The Nature Conservancy) can help to determine problem turf areas.

Outdoor Recreation

No recreational activities are permitted in this area, so recreation management practices are not applicable here.

9.2.7 Landscape – High Maintenance MEA

Landscaped areas that are intensively managed include historic and high visibility areas.

Many areas of Hickam AFB, Bellows AFS, and the other three satellite installations have been landscaped to increase their aesthetic value to base personnel and visitors. The Landscaped - High Maintenance (LHM) MEA has been developed to group these areas under one management approach, which is driven by Goal 6 (Grounds Maintenance and Urban Forestry), described in Section 8.1. The LHM MEA also supports Goal 4 (Watershed Protection) and Goal 10 (Coastal Resources) by defining management approaches that will limit nonpoint sources of pollution from intensively landscaped areas. Goal 7 (Commercial Forestry) could be supported at Hickam AFB by managing a program to allow collection of seed from selected landscaping species. Goal 8 (Outdoor Recreation and Public Access) also is supported through opportunities to interpret historic districts, including their landscaping, and to enhance visual quality associated with public access and recreation routes. In addition to their aesthetic value, several landscaped areas have historic importance. Hickam AFB personnel take tremendous pride in the landscaped areas that predate World War II. In the LHM MEA, management practices are applied to landscaped areas at a minimum of once per week.

Land Uses

The Landscaped - High Maintenance (LHM) MEA includes most of the landscaping around residential, commercial, and administrative buildings, high visibility areas, and the two golf courses at Hickam AFB. Of concern is the potential for fertilizers, herbicides, and pesticides to contribute to nonpoint source pollution of the canals. All of the developed land uses are compatible with this MEA except for airfield, aircraft operations and maintenance, and runways and taxiways which are designated for the BASH Reduction MEA.

Management practices in the LHM MEA include:

- Landscape design appropriate to site-specific conditions
- Control of pest animals, insects, and weeds, while minimizing the use of chemicals
- Use of native plants as appropriate to landscape design
- Regular maintenance of trees, shrubs, vines, turf, and other ornamentals
- Efficient application of irrigation water

Outdoor Recreation

Recreational activities such as hiking/walking, bicycling, wildlife watching, or nature study, are compatible with this MEA, but may be more appropriate in other MEAs such as the NRM or IR MEAs. Picnicking is conditionally compatible, depending on the specific location. For example, picnic tables suitable for lunching near Administrative buildings are compatible, but barbeque pits would not be compatible.

9.2.8 Landscaped – Low Maintenance MEA

Management decisions for areas in the Landscaped - Low Maintenance (LLM) MEA are also driven by Goal 6 (Grounds Maintenance and Urban Forestry). This MEA presents greater opportunities to minimize the amount of irrigation and labor needed for grounds maintenance and to maximize the use of native plants in landscaping than does the LHM MEA. Goals 4 (Watershed Protection) and 10 (Coastal Resources) also supported by defining management approaches that minimize the potential for nonpoint sources of pollution to reach waterways and coastal zones.

Landscaped areas lacking high maintenance vegetation are included in the LLM MEA

The LLM areas are generally along the shoreline at Hickam AFB and around buildings used for light industrial purposes at Bellows AFS and the Waikakalaua FSA (excluding those associated with aircraft operations, which are included in the BASH Reduction MEA). Grounds included in this MEA have a low level of maintenance, generally once every two weeks or

less. This MEA also includes semi-improved areas that contain turf that is mowed less frequently than once per week, and that lack high-maintenance vegetation in the form of shrubs, trees, vines, and flowers.

Land Uses

Light industrial and open space uses are compatible with the LLM MEA, because these areas generally do not require high maintenance landscaping. In addition, some of the aircraft operations and maintenance, housing, training, and outdoor recreation areas also provide opportunities for low maintenance landscaping. These uses are conditionally compatible with the LLM MEA. The remaining urban land and water uses are not compatible with the LLM MEA.

Management practices in the LLM MEA include:

- Increasing the use of native plants in landscaping
- Using turf management practices that allow for reductions in use of chemicals and irrigation water

Outdoor Recreation

Most recreational activities compatible with the LHM MEA are also compatible with the LLM MEA. Golf courses are clearly incompatible within this MEA, because they require a high level of maintenance. Model aircraft flying is compatible if it is not a hazard to airplanes at Hickam AFB and the adjacent Honolulu International Airport.

9.3 INSTALLATION MEAS

Not all of the MEAs are found at all installations. The smaller installations generally have two or three MEAs, whereas Hickam AFB has seven MEAs and Bellows AFS has six (Table 9.3-1). The acreages in Table 9.3-1 were obtained from the GIS and represent areas shown on the maps for each installation.

The acreages are calculated in the GeoBase based on mapped polygons. They will not agree exactly with acreages developed from other sources such as property maps. The MEA acreages are for the mapped area inside the installation perimeter. The following are descriptions of the MEAs for each of the installations.

TABLE 9.3-1 ACREAGE OF MANAGEMENT EMPHASIS AREAS ESTABLISHED FOR 15 AW INSTALLATIONS, OAHU AND KAUAI, HAWAII

		Management Emphasis Area							
Installation	Total Acreage	Managed Natural Habitat	Natural Resources Multiple Use	Watercourse	Intensive Recreation	Intensive Training	BASH Reduction	Landscaped High Maintenance	Landscaped Low Maintenance
Hickam AFB	2,520.5	0.0	920.7*	51.7	114.3	41.3	1006.7	1168.1	361.3
Bellows AFS	489.7	0.0	286.6*	25.3	148.9	0.0	0.0	24.2	0.0
Kipapa FSA	121.26	0.0	114.56	6.7	0.0	0.0	0.0	0.0	0.0
Waikakalaua FSA	28.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.2
Kaala AFS	6.6	1.5	0.0	0.0	0.0	0.0	0.0	2.6	0.0
Kokee AFS	10.0	4.7	0.0	0.0	00	0.0	00	4.4	0.7

* These acreages include offshore waters, and the MEAs will not add to the total installation acreage which is land-based.
Source: Natural resources management GeoBase.

9.3.1 Hickam AFB

Landscaped – High Maintenance and BASH Reduction are the largest MEAs.

Hickam AFB has seven of the eight MEAs (Figure 9-1, Table 9.3.1-1). (It does not include any Managed Natural Habitat MEA.) The **Landscaped - High Maintenance MEA** is the largest MEA at Hickam AFB. As might be expected from an active, urban Air Force base, the second largest land-based MEA is the **BASH Reduction MEA** encompassing the central portion of the base, while most of the remainder of the base is in MEAs that are designed to support the airfield and the other base tenants, including Headquarters PACAF. Combined, these two MEAs include the airfield, administrative, light industry, and housing areas in direct support of the 15 AW operational and support mission.

Some areas of light industry have been put in the **Landscaped - Low Maintenance MEA** rather than the Landscaped - High Maintenance MEA. These areas include warehouses and workshops in areas of low visibility to the Air Force command and visitors that do not require intensive landscaping. Other areas in the LLM MEA are open space, such as uncultivated fields containing barren ground and ruderal vegetation (i.e., weeds) or brushy areas that require limited maintenance.

The areas in the **Intensive Recreation MEA** include the baseball fields, the running track, and the BMX bike track. The IR MEA also includes picnic, beach, and boating areas at Honeymoon Beach and Hickam Harbor.

TABLE 9.3.1-1 COMPATIBILITY OF ACTIVITIES WITH MEAs AT HICKAM AFB

Management Emphasis Area	Fully Compatible		Conditionally Compatible	
	Land Uses	Outdoor Recreation	Land Uses	Outdoor Recreation
Landscaped – High Maintenance	• Lt. Industrial • Administrative • Community – commercial • Community – service • Medical • Housing – unaccompanied • Housing – accompanied	• Golf • Hiking walking • Bicycle use • Wildlife watching • Nature study	• Outdoor recreation	• Picnicking
Landscaped – Low Maintenance	• Lt. Industrial • Open space	• Hiking/Walking • Bicycle use • Wildlife watching • Nature study	• Aircraft O&M • Housing – unaccompanied • Housing – accompanied • Training • Outdoor recreation • Agriculture	• Picnicking • Archery
Natural Resources Multiple Use	• Open Space • Water	• Hiking/Walking • Wildlife watching • Nature study	• Training • Outdoor recreation • Agriculture	• Picnicking • Water sports • Bicycle use • Boating • Fishing • Archery
Watercourse	• Open space • Water	• Wildlife watching • Nature study	• Outdoor Recreation	• Hiking/walking • Boating • Fishing
Intensive Recreation	• Outdoor recreation • Open space • Water	• Picnicking • Water sports • Athletic fields • Model aircraft • Hiking/walking • Bicycle use • Boating • Wildlife watching • Nature study	• Administrative • Community – commercial • Community – service • Training	• Fishing • Archery
Intensive Training	• Training • Open space	• None	• Airfield • Runways • Taxiways • Outdoor recreation • Water	• Hiking/walking • Bicycle use • Fishing • Wildlife watching • Nature study • Archery
BASH Reduction	• Airfield • Aircraft O&M • Runways	• None	• Training • Agriculture	• Nature study

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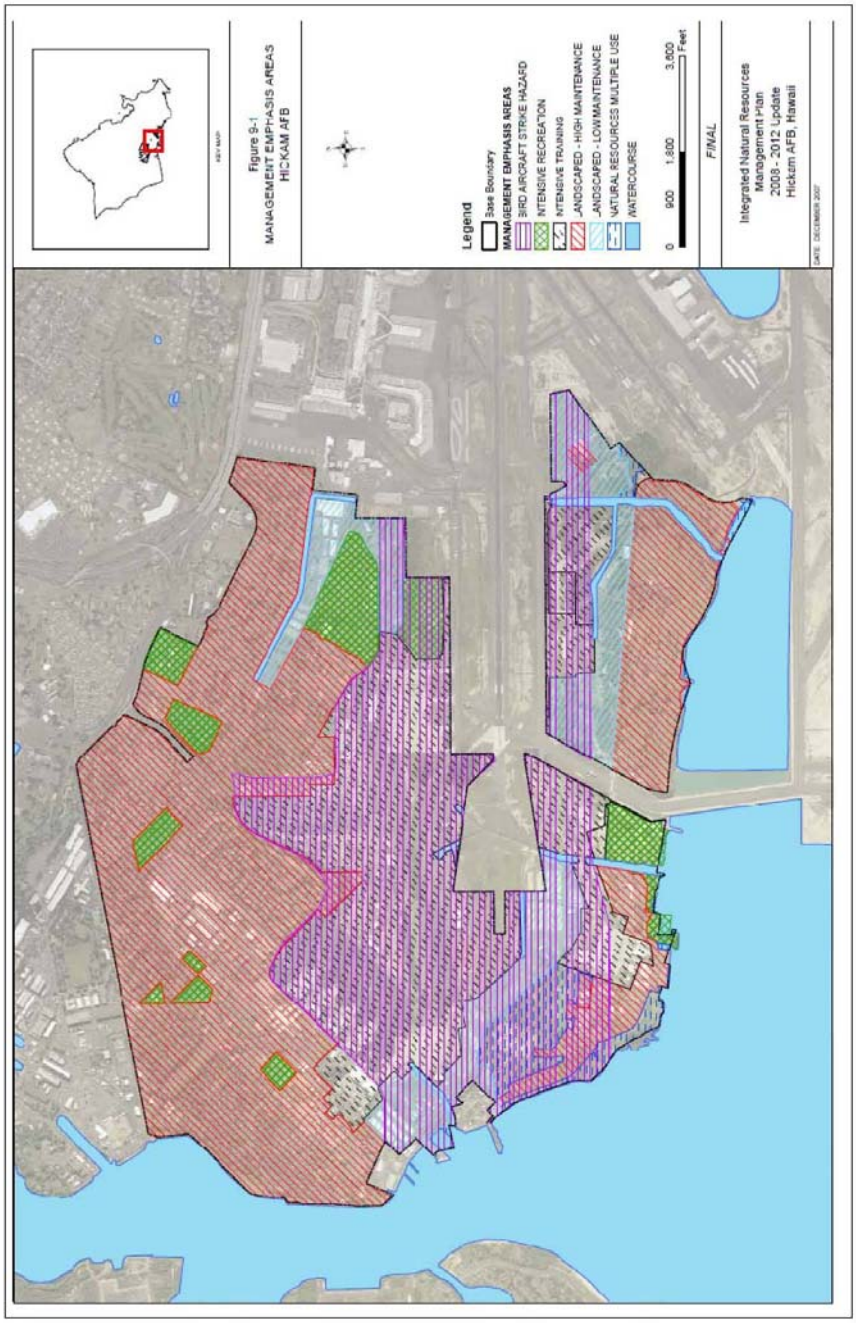
	• Taxiways • Open space			

The opportunities and constraints analysis helped identify areas meeting criteria for the Natural Resources Multiple Use MEA. Dispersed recreational activities such as biking and walking are compatible with the NRMU MEA. NRMU MEAs include the Ahua Reef coastal area and the Airport Lagoon (847 acres), an area on Fort Kamehameha adjacent to a residential area that includes a wetland, and other large wetlands located on the base that are not located in the Watercourse MEA.

The largest wetland in this MEA (10.7 acres at Fort Kamehameha) is currently considered to be of relatively low value because it has little vegetative cover, but it may be suitable for restoration and enhancement. A plan needs to be developed to determine the limiting factors that have reduced plant growth at this site and other factors relating to its suitability for enhancement. Restoration could complement development of a parcourse that is proposed in the Outdoor Recreation Plan (15 ABW 1995b) for location in this NRMU MEA. See Section 10.3.2.5.

The sand islands in the Airport Lagoon at the mouth of Manuwai Canal may have potential for blacknecked stilt nesting habitat, because they provide protection from land-based predators such as cats and mongoose. However, it is unclear to what extent this would increase BASH for the nearby runway, or if airport noise makes this area unsuitable. The APHIS-ADC is concerned about habitat enhancement for stilt, because they could fly over the flight line on their way to existing nesting areas. The area should be monitored for black-necked stilt activity, and enhancement for nesting and/or foraging should be implemented only if it does not conflict with the flying mission. Human access should be limited, at least in the short term, but it is not necessary to constrain nearby golf-related activities in order to protect existing foraging habitat.

The stormwater canals are included in the Watercourse MEA, the smallest MEA at the installation. The priority management objective for the canals will be conveyance of stormwater off the base. Some activities, such as removing sediments from the canals, could have a dual benefit by increasing both stormwater conveyance and the quality of habitat for aquatic species. Removal of thick sediments would improve water quality by increasing the circulation of marine and brackish waters and by removing any hazardous materials that may be in the sediments. Dredging to remove sediments is subject to a review of potential environmental impacts (under NEPA) or a nationwide permit exemption. A



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35-foot buffer is established along the main stem canals. Within this buffer, stream bank stabilization and riparian vegetation enhancement is proposed to the extent that this does not increase BASH near the airfield or in the flight lines.

Waikakalaua Stream near Wahiawa

One area adjacent to the airfield has been categorized as Intensive Training on the basis of its current use ("prime BEEF"). At present, this area is in poor condition for use by wildlife (i.e., conditions include rubbish piles, areas cleared of vegetation, and low-value wetland along the drainage ditch). It should be restored and reassigned to the Landscaped - Low Maintenance or the Natural Resources Multiple Use MEA, if training exercises are moved to a different area or installation. Rubbish should be removed regardless of whether training exercises continue in the area.

9.3.3 Hickam POL Pipeline System (Kipapa and Waikakalaua FSAs)

The Hickam POL Pipeline was taken out of service in 1993, and the two fuel storage annexes are being decommissioned as well. Portions of the facilities, such as aboveground piping, are planned for removal. Land management activity is focused at the FSAs as described below.

9.3.3.1 Kipapa FSA

Kipapa FSA's two MEAs are shown on Figure 9-3 and in Table 9.3.3-1. The Watercourse MEA includes Kipapa Stream plus a 35-foot riparian buffer on each side of it. No buffer was provided for the irrigation ditch on the eastern side of the installation because the ditch is not a watercourse to be managed by the Air Force. Acceptable activities in this MEA include stream bank modification to allow the stream to flood within its natural floodplain, which could contribute to the enhancement of the jurisdictional wetlands and riparian zone present on the installation (if selected as a "wetland mitigation" project).

Kipapa Stream at Kipapa FSA

TABLE 9.3.3-1 COMPATIBILITY OF ACTIVITIES WITH MEAs AT KIPAPA FSA

Management Emphasis Area	Fully Compatible		Conditionally Compatible	
	Land Uses	Outdoor Recreation	Land Uses	Outdoor Recreation
Natural Resources Multiple Use	• Open space • Water	• Hiking/Walking • Wildlife watching • Nature study	• Training • Outdoor Recreation • Agriculture	• Picnicking • Bicycle use • Fishing • Archery
Watercourse	• Open space • Water	• Wildlife watching • Nature study	• Outdoor Recreation	• Hiking/Walking • Fishing

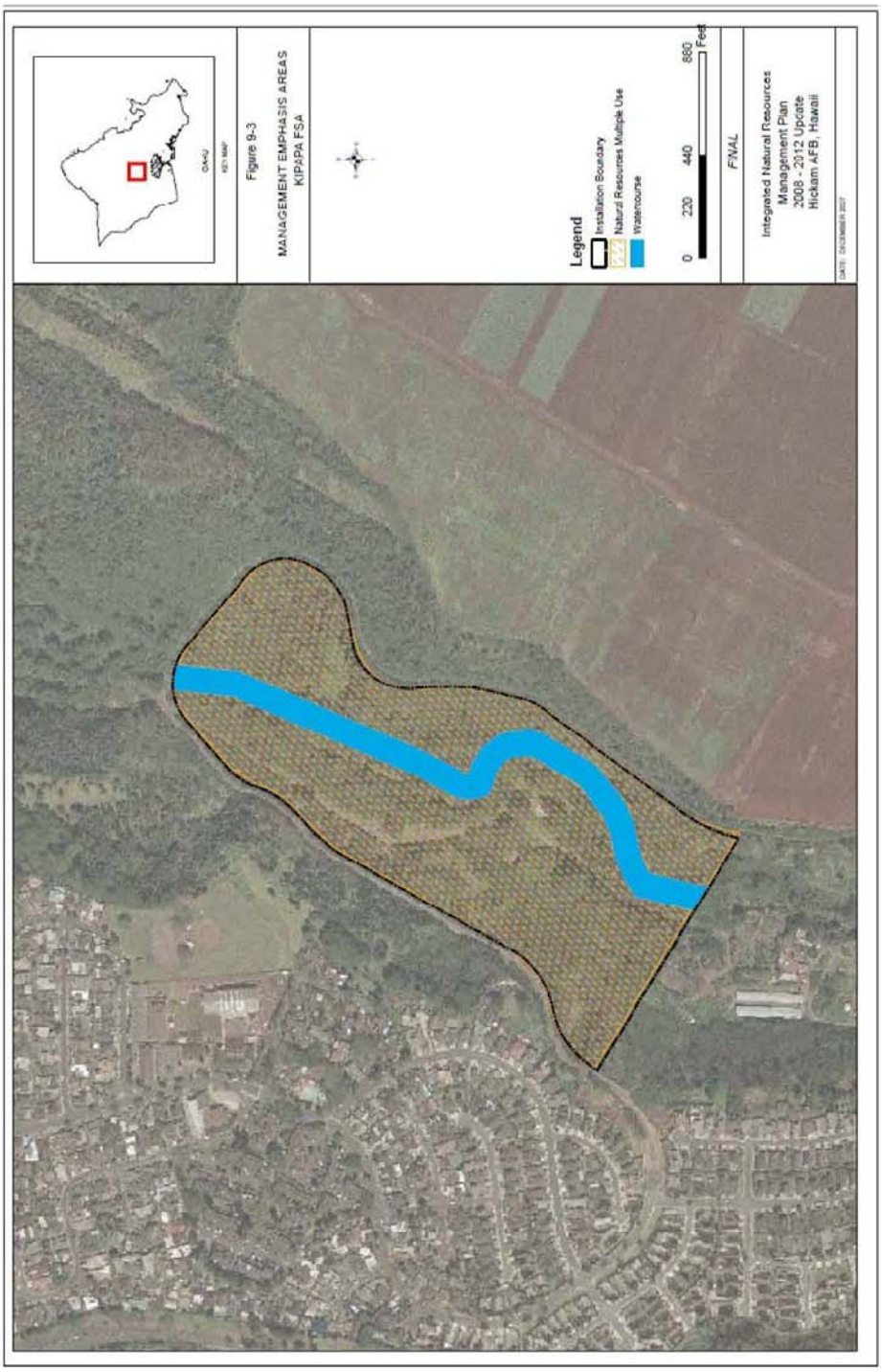
Although much of the installation currently has a low level of landscape maintenance (mowed turf), the remaining area of the installation was placed in the Natural Resources Multiple Use MEA. The presence of a favorable soil type, Haleiwa silty clay, 0-2 percent slopes, suggests that an area within the NRMU MEA could be considered for conversion to an agricultural outlease or field holding area for native Hawaiian plant species for use in restoration of sites on other Air Force lands on Oahu. At a minimum, conversion of mowed turf to native vegetation should be considered. Control of erosion and sediment-laden runoff to Kipapa Stream are important objectives to pursue during any multiple-use development.

9.3.3.2 Waikakalaua FSA

All of the FSA is assigned to the Landscaped - Low Maintenance MEA, consisting of infrequently mowed turf that covers the entire installation (Figure 9-4, Table 9.3.3-2).

TABLE 9.3.3-2 COMPATIBILITY OF ACTIVITIES WITH MEAs AT WAIKAKALAUA FSA

Management Emphasis Area	Fully Compatible		Conditionally Compatible	
	Land Uses	Outdoor Recreation	Land Uses	Outdoor Recreation
Landscaped – Low Maintenance	• Lt. Industrial • Open space • Agriculture	• Hiking/Walking • Bicycle use • Wildlife watching • Nature study	• Training • Outdoor recreation	• Picnicking • Archery



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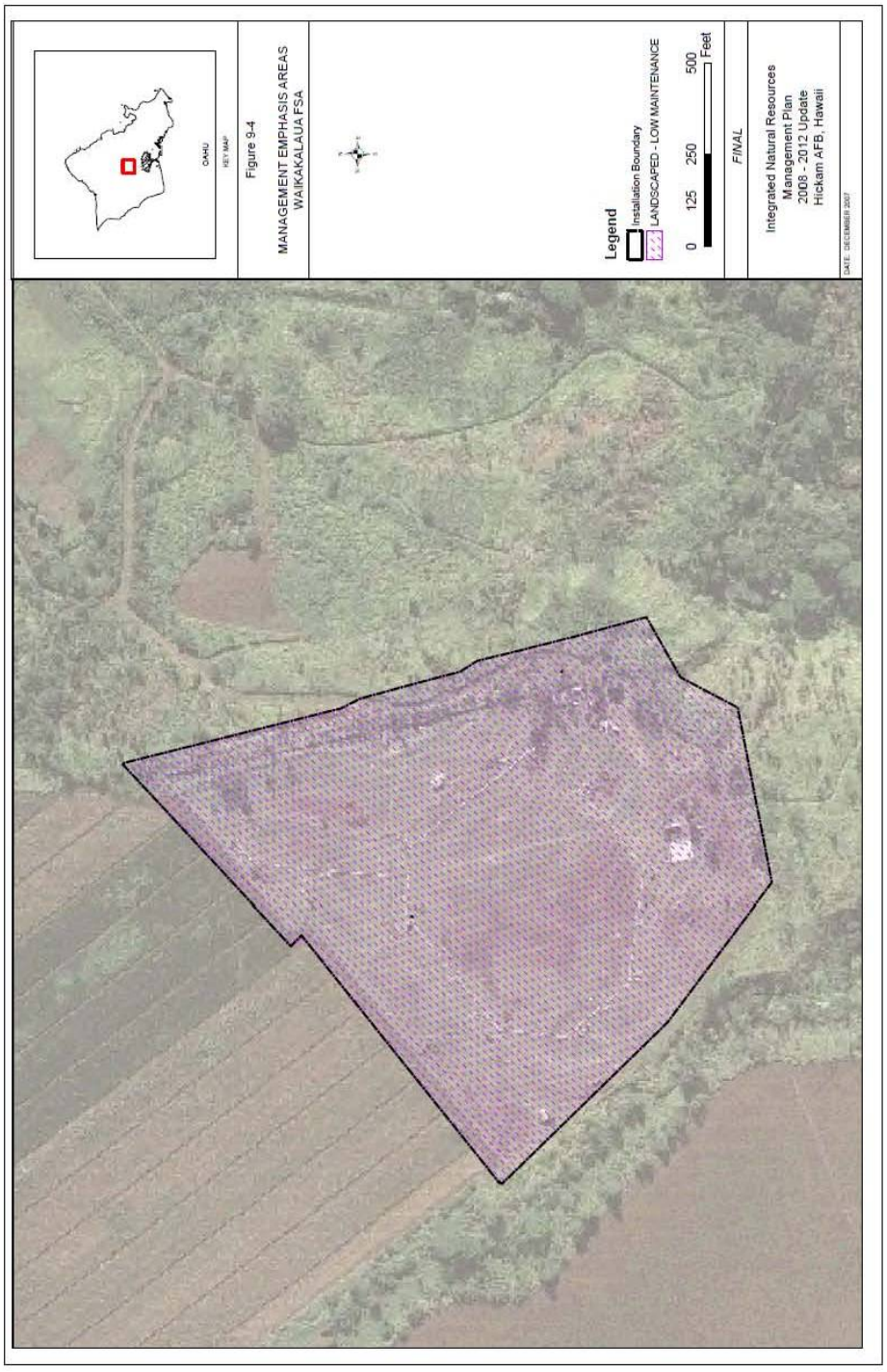

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TABLE 10-1A OPERATIONAL COMPONENT PLAN PROJECTS BY GOAL AND FUNDING LEVEL

Report Section	Project Name (Priority)	Goals*											Funding Level
		1	2	3	4	5	6	7	8	9	10	11	
10.2.2.1	Incidental Take Permits (1)	X	X			X							1
10.2.2.2	Exotic Predator Control (21)	X	X			X							2
10.2.2.4	Natural Resources Web Page (29)	X	X	X		X			X		X		3
10.2.2.5	Monitoring Surveys (2)	X	X			X					X		1
10.2.2.6	Black-necked Stilt Radiotracking (37)	X	X			X							3
10.3.2.1	Section 404 Permit – Training in Wetlands (3)	X		X									O&S
10.3.2.2	Permanent Wetland Database (6)	X		X									1
10.3.2.3	Long-term Monitoring of Wetland Functions (19)	X		X									2
10.3.2.4	Wetland Enhancement at Fort Kamehameha (26)	X	X	X									3
10.3.2.5	High-value Wetland Reserve Area Restoration (25)	X	X	X									3
10.3.2.6	Wetland Restoration at Bellows AFS Oxbow (24)												
10.4.2.1	Watercourse Sediment Removal Feasibility Study (9)	X	X		X	X					X		NA
10.4.2.2	Watershed Assessment (20)	X		X	X	X					X		2
10.4.2.3	Riparian Enhancement (27)	X	X		X	X					X		3
10.4.2.4	Watercourse Conveyance Enhancement (4)	X			X	X							O&M
10.5.2.8	Exotic Fish Eradication (28)	X				X							3
10.6.2.1	Control of Invasive Plant Species (10)	X	X			X							1

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10.6.2.2	Urban Tree Inventory (11)	X				X							3
10.6.2.3	Woody Fuel and Flammable Vegetation Survey and Removal (32)	X				X							3
10.6.2.4	Reorganization/Training for Grounds Shop (33)	X				X							3
10.6.2.5	Self-Guided Horticultural Interpretive Tour (38)	X				X		X					3
10.6.2.6	Landscape Development Master Plan (22)	X	X			X							O&M
10.6.2.7	Tree City USA Designation (7)	X				X							3
10.6.2.8	Revegetation: Ammunition Storage/Training Area (35)	X					X						O&M or 3
10.6.2.9	Urban Forestry Management Plan (23)	X					X						2
10.7.2.1	Urban Tree and Plant Seed Harvest (36)	X						X					3
10.8.2.1	Recreation and Environmental Education Needs Assessment (13)	X							X				2
10.8.2.2	Shoreline Access/ Interpretive Trails (14)	X		X		X	X		X		X		3X
10.8.2.3	Bird Watching Guide (34)	X				X			X				3
10.8.2.4	Harbor Park Enhancement (16)	X							X				None
10.8.2.5	Trail Impact Monitoring and Maintenance Program (15)	X		X	X				X				None
10.9.2.1	Outleasing for Native Plant Horticulture (31)	X	X				X			X			3
10.10.2.1	Boat Best Management Practices Signs (30)	X	X								X		3
10.11.2.2	Ahua Reef Cleanup (5)	X	X						X		X		3
10.11.2.1	GeoBase Accessibility (8)	X										X	None

10.11.2.2	Integration with Other Databases and CADD (12)	X										X	None
10.11.2.3	New Aerial Photography and Photogrammetry (17)	X										X	None
10.11.2.4	Maintain/Update Natural Resource Data Layers (18)	X										X	None
10.11.2.5	Additional Natural Resource GeoBase Layers (39)	X										X	None

*(1) Land Uses and Military Mission, (2) Threatened or Endangered Species and Critical Habitats, (3) Wetlands, (4) Watershed Protection, (5) Fish and Wildlife Management, (6) Grounds Maintenance and Urban Forestry. (7) Commercial Forestry, (8) Outdoor Recreation and Public Access, (9) Agricultural Outleasing, (10) Coastal Resources, and (11) GeoBase.

**Level 1=Fix Noncompliance, Level 2 = Prevent Noncompliance, Level 3 = Beyond Compliance, O&S = Operations and Services, O&M = Operations and Maintenance, NA = Not Available.

Note: Estimated cost of projects is included in Appendix G, Tables G-2A through G-2H.

In Table 10-1A, projects are prioritized or ranked from 1 through 39 based on A106 funding requirements, installation needs, and the judgment of environmental planners.

In addition to the funding sources, each operational component plan project includes an estimated cost. The cost estimates were initially developed by EA Engineering, Science, and Technology, the company that prepared the 1998-2002 INRMP, and were based on 1997 labor rates and materials cost. They were reported in constant 1997 dollars. These 1997 cost estimates have been updated to 2007 labor rates and materials costs for this 2008-2012 INRMP Update. These estimates are to be used for planning purposes and will be refined when projects are put out to bid. Costs are expected to increase with annual increases in the cost of living in Hawaii, and these cost increases have not been factored into the cost estimates presented in this chapter and in Appendix G.

Projects are listed in each operational component plan by funding source such as ACES-PM, Conservation Resources Funding and its three funding levels. The complete description of each project is not presented necessarily by its funding priority, because priorities for implementation changed during plan preparation and are expected to change over the planning period.

DoD Instruction (DoDI) 4715.3 *Environmental Conservation Program* (May 1996) provides additional information on funding natural and cultural resources conservation management requirements. This DoDI provides a more comprehensive list of projects that can be funded under each Level than the AFI 32-7001.

Additional tables for operational component plan projects are contained in Appendix G, Operational Component Plans Project Summary Tables.

- Table G-1 is a listing of the operational component plan projects by installation.
- Table G-2 is a table that summarizes the operational component plan projects by fiscal year, 2008 through 2012, including sources of funds and estimated cost by fiscal year. Summaries for each installation are included in this series. Projects are listed in the order in which they are described in this chapter.
- Table G-3 is a series of five tables, one for each installation, that indicates the problems resolved or issue addressed by each operational component plan project.

Interagency Coordination

The Air Force is currently cooperating with local, state, and federal agencies to manage resources at its installations. To enhance interagency coordination, the Air Force has the following cooperative agreements with state and federal agencies:

- Memorandum of Understanding (MOU) Relating to the Pearl Harbor Estuary Program, February 1993, between the U.S. Department of the Air Force and 16 other federal, state, and local agencies (Appendix E)
- MOU for the Conservation and Development of Fauna (Animals) and Flora (Plants), 9 April 1986, between 15 ABW, USFWS, and DLNR (Appendix H)

These agreements facilitate agency consultation for implementation of wildlife and habitat conservation projects and for control of nonpoint source pollution in the Pearl Harbor Estuary. In addition to the formal agreements, AFI 32-7064 outlines coastal and marine resources coordination, endangered species coordination, and wetland permitting.

Ongoing technical assistance is available from USDA APHIS-ADC upon request. APHIS-ADC has signed an MOU to handle wildlife problems at DoD installations. Operational assistance is also available if requested and funded.

No formal cooperative agreement currently exists between the Air Force and MCBH; however, due to the proximity of MCTAB to Bellows AFS and its co-location within the same watershed, coordination between the two agencies is highly recommended. Potential areas for coordination include wetland management, watershed management, control of invasive species, outdoor recreation management, and geobase/data management. Coordination with MCBH, when appropriate, is included in the description of OCP projects.

A list of Air Force, other military, and agency contacts for natural resources is provided in Appendix I.

Management Emphasis Areas

The Management Emphasis Areas (MEAs) discussed in Sections 9.2 and 9.3 are a primary mechanism for plan implementation. These land management units represent an implementation approach that is tied to the resources, their geographic locations, and the base comprehensive

planning process. The implementation projects in this chapter apply to one or more of these eight MEAs:

- Managed Natural Habitat
- Natural Resources Multiple Use
- Watercourse
- Intensive Recreation
- Intensive Training
- BASH Reduction
- Landscaped - High Maintenance
- Landscaped - Low Maintenance

Schedule for Implementation

The INRMP has an implementation time frame of 5 years. AFI 32-7064 requires listing of projects to be accomplished within the two fiscal years following approval of the INRMP by the Environmental Leadership Council (ELC, the 15 AW's environmental protection committee). Listed projects are assigned to three priority groupings: ACES-PM Level 1 projects are those to be accomplished in fiscal years 2008-2009, and Levels 2 and 3 projects are those to be completed in the next 3 years, 2010-2012. This timing does not preclude Levels 2 and 3 projects from beginning before 2010 if the opportunity arises. A summary of all the projects contained in this chapter is provided in Table G-2 (Appendix G) with the projects listed (by section) and estimated costs shown by fiscal year.

Progress Made Since Last INRMP Update

Since the development of the 2003-2007 INRMP, five listed projects have been implemented or are in the process of being implemented; these projects are identified and summarized in Table 10-1B. Two new projects, High-value Wetland Reserve Area Restoration (Section 10.3.2.5) and Wetlands Restoration at Bellows AFS Oxbow (Section 10.3.2.6), have been added to the list.

Unfunded and/or unimplemented projects from the 2003 INRMP are again identified in this Update for reallocation of funding and scheduling.

TABLE 10-1B OPERATIONAL COMPONENT PLAN PROJECTS IMPLEMENTED SINCE 2003-2007 INRMP UPDATE

Project Name	Comments
Incidental Take Permits	Hickam AFB is currently in consultation with the USFWS regarding incidental take of four endangered Hawaiian waterbirds--coots, stilts, moorhen, and koloa.
Monitoring Surveys	Monitoring surveys for all installations are being conducted by the natural resource manager on a periodic basis.
Turtle Protection Signs	Execution plan for project completed in March 2004. Signs subsequently installed at Bellows AFS.
Shoreline Access/Interpretive Trails	Ten interpretive signs addressing various aspects of local ecosystems have already been installed along the trail location.

New Aerial Photography and Photogrammetry	2006 aerial imagery of Bellow AFS has been incorporated into GeoBase.

10.1 LAND USES AND MILITARY MISSION OPERATIONAL COMPONENT PLAN

The military mission at each installation occurs in an overall ecosystem that has both natural elements and constructed facilities. The Air Force strives to be a good steward of the environment in Hawaii and to fulfill its military missions, including changes in those missions. The focus of this section is on how to incorporate natural resources information into the overall planning process to further both of these objectives simultaneously.

The first section summarizes plan implementation, while the operational component plan section identifies specific actions or projects to accomplish the goals and objectives of this INRMP.

10.1.1 Implementation Summary for Land Uses and Military Mission

Goal 1: Encourage utilization and management of installation natural resources consistent with the Air Force mission.

Table 10.1-1 summarizes how each objective is to be implemented.

The base comprehensive planner must be connected into the GeoBase through the local area network to fully implement these objectives. If not, the planner must be given hard copies/plots of all of the resource maps.

TABLE 10.1-1 IMPLEMENTATION SUMMARY FOR LAND USES AND MILITARY MISSION

Objective 1.1: Protect natural resources existing on Air Force installations.			
Implementation Process	**Project/Action**	**Report section**	**Applicable Installations**
Update the identification of resources (resource inventories) as new information becomes available.	1. Continue to conduct monitoring surveys for species and habitat.	10.2.2.5	All
	2. Take new aerial photos of the sites.	10.11.2.3	All
	3. Develop new GeoBase layers.	10.11.2.5	All
Continue coordination with USFWS and DLNR. Maintain/update existing environmental permits, and obtain new permits when required.	1. Continue Section 7 consultation with USFWS.	10.2.2.1	Hickam AFB
	2. Implement Exotic Predator Control Project.	10.2.2.2	All
	3. Implement Section 404 Permit – Training in Wetlands Project.	10.3.2.1	Hickam AFB
	4. Implement Section 404 Permit – Clearing Vegetation in Canals Project	10.3.2.2	Hickam AFB
	5. Implement Exotic Fish Eradication Project.	10.5.2.8	Hickam AFB

Orient newcomers to each base about the base's natural resources.	1. Create a Natural Resources Web Page.	10.2.2.4	All
	2. Develop self-guided horticultural interpretive tour.	10.6.2.5	Hickam AFB
	3. Provide shoreline access and interpretive trails.	10.8.2.2	Hickam AFB
	4. Create a bird watching field guide.	10.8.2.3	Hickam AFB Bellows AFS
Implement INRMP Update by allocating sufficient manpower to natural resources management.	1. Hire an assistant to natural resources manager.	10.1	All
	2. Hire administrative support		
Objective 1.2: Update the resource opportunities and constraints analysis as new natural resource information becomes available and as the mission changes.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Review the opportunities and constraints analysis more frequently than once every 5 years as new information is available.	1. Continue to conduct monitoring surveys for species and habitat conditions.	10.2.2.5	All
	2. Take new aerial photos of the sites.	10.11.2.3	All
Produce a new opportunities and constraints map annually, and distribute it to users of the INRMP.	1. Maintain and update natural resource data layers.	10.11.2.4	All
	2. Develop additional GeoBase layers as necessary.	10.11.2.5	All
Objective 1.3: Incorporate natural resources information into the land use planning and development processes to avoid or minimize the potential for recreation, training, and other land uses to conflict with resource values and to take advantage of opportunities for natural resource preservation and for development.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Keep installation base maps and resource maps up to date, and ensure that the base comprehensive planner has access to the GeoBase.	1. Implement GeoBase Accessibility Project.	10.11.2.1	All
	2. Maintain and update natural resource data layers.	10.11.2.4	All
The natural resource manager and base comprehensive planner are to meet quarterly to review potential mission changes and discuss resource issues.	1. The base comprehensive planner is to consult the INRMP MEAs when considering potential locations for new facilities or changes in activity.	None	All

The natural resources manager also needs to coordinate with other groups through the Facilities Board at Hickam AFB.	1. Attend Facilities Board meetings.	None	Hickam AFB
Objective 1.4: Evaluate the impacts of the military mission on the natural environment consistent with the requirements of AFI 32-7061 to implement the National Environmental Policy Act.			
Implementation Process	Project/Action	Report Section	Applicable Installations
Use the INRMP and resource maps in the GeoBase for the review of proposed projects under NEPA.	**1. Implement the GeoBase Accessibility Project.**	**10.11.2.1**	**All**

10.1.2 Operational Component Plan Projects

Meeting the goal and objectives above is dependent upon implementation of several projects in this INRMP, especially the following information-oriented projects:

- Monitoring Surveys (Section 10.2.2.5)
- Maintain/Update Natural Resource Layers (Section 10.11.2.4)
- New Aerial Photography (Section 10.11.2.3)
- Additional Natural Resource Layers (Section 10.11.2.5)
- GeoBase Accessibility (Section 10.11.2.1)
- Natural Resources Web Page (Section 10.2.2.4)

The Monitoring Surveys Project is presented in Section 10.2.2.5, while the four GeoBase projects are contained in Section 10.11.2. The educational project which would help orient newcomers, Natural Resources Web Page, is described in Section 10.2.2.4.

MEA Revisions

Revisions to the MEAs may be needed over time to accommodate mission changes (including installation boundary changes) or changes in natural resources present on the installation. These revisions need to consider the most recent resource information available. Changes to the three most protection-oriented MEAs (Managed Natural Habitat, Natural Resources Multiple Use, and Watercourse) especially require careful scrutiny of the resources to minimize or avoid impacts to the resources.

Manpower Requirements

Implementation of all of the operational component plans in this INRMP requires additional manpower. Since the development of the 2003-2007 INRMP Update, a natural resources manager has been hired. However, the natural resources manager needs a full-time assistant to help with project oversight and resource information needs. The assistant should be a GS-9 civilian employee with a background in terrestrial or aquatic ecology, wildlife biology, or botany. Familiarity with GeoBase is also a requirement.

10.2 THREATENED OR ENDANGERED SPECIES AND CRITICAL HABITATS OPERATIONAL COMPONENT PLAN

The installations with the greatest probability of harboring or affecting threatened and endangered (T&E) species are Hickam AFB, Bellows AFS, Kaala AFS, and Kokee AFS (see Table 6-1, Introduction to Chapter 6). Plant and/or animal species were either observed at, or nearby, these installations or have a reasonable possibility of occurring at these installations. This does not mean the other installations should be ignored in future studies, because conditions may change over time. For example, an injured pueo was relocated from Hickam AFB to Kaena Point STS (now managed by USAF Space Command), and others could be relocated there or to other installations with active predator control. With improvements in habitat conditions over time, the possibility of finding T&E species and/or other native species of state/local concern exists at all installations.

Management Practices

The plan implementation summary presented in the following section includes important management practices that are not specific projects. For example, injured, threatened, and endangered wildlife may be found at any installation, including those where the animal is not expected to occur. If an injured animal is encountered, it will be monitored on-site or rescued and removed if in a life-threatening situation. It will be held (or monitored) until DLNR can provide assistance for care, rehabilitation, and release of the animal.

The practice of bringing exotic plant and animal species to the Hawaiian Islands began with the earliest visits by Polynesian peoples, and has continued throughout most of the modern history of the islands. These introductions have led to a widespread reduction in the abundance and diversity of endemic Hawaiian species through competition and predation by exotics. To improve the outlook for the long-term success of native plant and animal species, all of the installations need to consider controlling invasive plant species and using native plants for future restoration projects and in landscape planning. These practices will improve habitat for T&E species and other native species needing conservation and protection.

Cooperative Efforts

Establishment of T&E plant populations on lands managed by 15 AW generally is not feasible, except as nursery projects, due to the extent of disturbance and the small size of most of the properties. However, the Air Force could enter into a cooperative effort with DLNR and USFWS to establish and maintain non-Air Force lands that are outplanted with T&E species. One prime location would be the area to the south of Kaala AFS that is currently being invaded by Florida blackberry. It is possible that *Alsinidendron trinerve* could be established in this area if the blackberry is strictly controlled, and if the area is fenced to prevent damage by feral pigs, as recommended by the *Recovery Plan for the Waianae Plant Cluster* (USFWS 1995). DLNR and USFWS should be consulted if the Air Force is interested in pursuing off-site rare plant establishment.

10.2.1 Implementation Summary for Threatened and Endangered Species and Critical Habitats

Goal 2: Ensure the protection of any threatened and endangered species and habitat critical to their survival that may occur on Air Force lands.

Table 10.2-1 summarizes how each objective is to be implemented.

TABLE 10.2-1 IMPLEMENTATION SUMMARY FOR T&E SPECIES AND CRITICAL HABITATS

Objective 2.1: Identify which threatened and endangered (T&E) species occur or are likely to occur on Air Force lands and where they occur.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Potentially occurring T&E species have been identified for each installation during the development of this Plan and are listed in Appendixes C and D.	1. Update list as part of the monitoring surveys for species and habitat.	10.2.2.5	All
Objective 2.2: Incorporate protection of habitats utilized by threatened and endangered species into the INRMP Management Emphasis Areas. Minimize conflicts between protection of threatened and endangered species and other military activities.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
The Managed Natural Habitat MEA protects T&E species by restricting the number of permitted activities.	1. Refer to this INRMP when evaluating land uses and activities.	9.2.1	Kaala AFS Kokee AFS
The Natural Resources Multiple Use (NRMU) MEA accommodates foraging habitat for T&E species with other selected activities.	1. Conduct annual cleanup of Ahua Reef.	10.10.2.2	Hickam AFB
The Watercourse MEA is used by black-necked stilts. Conflicts with military activities are minimized by spatially separating activities from important T&E habitat areas.	1. Implement Black-necked Stilt Radiotracking Project.	10.2.2.6	Hickam AFB
Objective 2.3: Develop and implement habitat enhancement plans that will benefit threatened and endangered species.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**

Evaluate habitat enhancement opportunities at Hickam AFB for black-necked stilt.	1. Implement Black-necked Stilt Radiotracking Project.	10.2.2.6	Hickam AFB
Improve green sea turtle habitat.	1. Implement Ahua Reef Cleanup Project.	10.10.2.2	Hickam AFB
Evaluate the possibility for improving water quality at Hickam AFB.	1. Implement Sediment Removal Feasibility Study.	10.4.2.1	Hickam AFB
	2. Implement Boat BMP Signs Project.	10.10.2.1	Hickam AFB
Improve riparian habitat at Bellows AFS.	1. Implement Riparian Enhancement Project.	10.4.2.3	Bellows AFS
Remove exotic vegetation and replace with native vegetation at Kaala AFS and Kokee AFS.	1. Implement Control of Invasive Plant Species Project.	10.6.2.1	Kaala AFS Kokee AFS
Objective 2.4: Develop and implement an exotic predator control program for feral cats, mongoose, rats, etc. in areas where these animals are destructive to threatened and endangered species. Incorporate protection from predators in habitat enhancement plans.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Reduce the presence of predators.	1. Implement Exotic Predator Control Project.	10.2.2.2	All
Work cooperatively with DLNR and USDA.	1. Implement Exotic Predator Control Project.	10.2.2.2	All
Determine the extent of exotic predator presence on installations. To the extent possible, maintain records of casual observations of predators by installation personnel. Provide easy avenues for reporting observations.	1. Implement Exotic Predator Control Project.	10.2.2.2	All
	2. Include exotic predator reporting opportunities when implementing the Natural Resources Web Page Project.	10.2.2.4	All
	3. Develop exotic predator reporting opportunities through email and other avenues.	None	All
	4. Educate base personnel about predator control, especially pet owners.	Appendix R	All
Objective 2.5: Where native vegetation is in close proximity to Air Force lands, control invasive non-native plant species that could spread into native vegetation and potentially impact T&E species.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**

Discuss the scope of the problem with AF groundskeepers and contractors. Reduce the current stock of exotics. Control exotics during regular maintenance activities.	1. Implement Exotic Predator Control Project.	10.2.2.2	Kaala AFS Kokee AFS
Do not use invasive exotic species in landscaping.	1. Implement Exotic Predator Control Plan.	10.2.2.2	Kaala AFS Kokee AFS
	2. Implement Control of Invasive Plant Species Project.	10.6.2.1	Kaala AFS Kokee AFS
Objective 2.6: In restoring areas distributed by military activities, use native plant species to improve habitat for T&E species and other native species whenever possible.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Utilize native plants that complement the surrounding area during revegetation projects. Use juvenile plants derived through the implementation of Native Plant Horticulture Project. If appropriate plants are not available from this project, use plants from a local native plant nursery.	1. Include appropriate native plant species as part of the Landscape Development Master Plan.	10.6.2.6	All
	2. Include appropriate native plants as part of the Wetland Enhancement at Fort Kamehameha Project.	10.3.2.5	Hickam AFB
	3. Include appropriate native plants as part of the High-value Wetland Reserve Area Restoration Project.	10.3.2.6	Hickam AFB
	4. Implement Outleasing for Native Plant Horticulture Plan and include appropriate revegetation species.	10.9.2.1	Hickam AFB Kipapa FSA Waikakalaua FSA
Objective 2.7: Maintain established procedures for handling incidental occurrences of threatened and endangered species on Air Force lands, especially injured animals that are found on installations.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Develop handling procedures cooperatively with the USFWS, DLNR, and/or Humane Society.	1. Develop handling procedures as needs arise.	None	All
	2. Include handling procedures as part of Incidental Take Permits Project.	10.2.2.1	Hickam AFB Kokee AFS
Publish handling procedures.	1. Publish procedures on the Natural Resources Web Page.	10.2.2.4	All
	2. Include procedures with the Endangered Species Reference Book and future revisions of the Hickam AFB Housing Guide.	None	Hickam AFB
Objective 2.8: Comply with local, state and federal laws and regulations regarding native and threatened and endangered species.			
Implementation Process	**Project/Action**	**Report**	**Applicable Installations**

		Section	
Obtain any necessary Incidental Take Permits.	1. Implement Incidental Take Permits Project.	10.2.2.1	Hickam AFB Kokee AFS
Consult Appendix J for applicable statutes, responsible agency, and contacts for compliance.	1. Prepare update of Appendix J.	Appendix J	All

10.2.2 Operational Component Plan Projects

The Operational Component Plan for Threatened or Endangered Species includes six projects. Of these, two are first priority (Level 1, Fix Noncompliance, to be accomplished by 2008), one is second priority (Level 2, Prevent Noncompliance, to be accomplished by 2009), and three are third priority (Level 3, Beyond Compliance, to be accomplished by 2012). The following projects help to implement Goal 2 objectives:

- Level 1
  - Incidental Take Permits
  - Monitoring Surveys
- Level 2
  - Exotic Predator Control
- Level 3
  - Ahua Reef Cleanup
  - Natural Resources Web Page
  - Black-necked Stilt Radiotracking

In addition, two projects that are presented in Section 10.6 under the Operational Component Plan for Grounds Maintenance and Urban Forestry (10.6.2.1 Control of Invasive Plant Species) and Section 10.9 under the Operational Component Plan for Agricultural Outleasing (10.9.2.1 Outleasing for Native Plant Horticulture) also contribute to reaching Goal 2 objectives.

10.2.2.1 Incidental Take Permits

When otherwise lawful activities result in accidental, occasional mortality of listed animal species, the USFWS or NOAA's NMFS, in compliance with the Endangered Species Act, requires that the responsible party obtain an incidental take permit. In processing the permit application, the USFWS or NMFS determines the expected impacts on the population in question and may recommend mitigating activities. Figure 10-1 illustrates the Endangered Species Act (ESA) coordination process, while Appendix Q contains ESA-related documents (guidance on the Section 7 consultation process, a letter from USFWS requesting that 15 AW only request informal Section 7 review when there is a chance of affecting RTE species or migratory birds, and several sample 15 AW letters requesting informal review of 15 AW projects).

Bird-aircraft strike records at Hickam AFB indicate that at least one black-necked stilt has been killed by commercial aircraft in the vicinity of the runways. Flight operations at Hickam AFB could result in future mortality of T&E species. Since the completion of the 2003 INRMP, Hickam AFB has proceeded with Section 7 review and is currently in consultation with the

USFWS regarding incidental take of four endangered Hawaiian waterbirds--coots, stilts, moorhen, and koloa. The consultation process will result in a series of recommendations provided by USFWS to Hickam AFB. Implementation of these recommendations falls under funding category Level 1.

Kokee AFS personnel have reported picking up Newell's shearwater (*Puffinus auricularis newelli*) and that grounded birds have been found at the installation. These fallout instances are a form of take. Also at Kokee AFS, the endangered Hawaiian hoary bat (*Lasirus cinereus semotus*) may be impacted by electromagnetic radiation emitted by the installation's radar dome, although no records of such an occurrence currently exist. (However, a monitoring survey to assess any potential impacts of the electromagnetic field on the bats is proposed; see Section 10.2.2.5). The Air Force will consult with USFWS regarding these situations and conduct Section 7 review for Newell's shearwater and, possibly, for the Hawaiian hoary bat.

The Hickam AFB portion of this project cost estimate is based on an effort of 8 hours per week (or 20% of a $54,000 annual salary) for an assistant natural resources manager to monitor implementation of the USFWS recommendations. For the Kokee AFS portion, the cost estimate is based a on projected hourly rate of $96 for a wildlife biologist and/or permitting specialist to prepare a biological assessment. An additional $4,800 of expense is projected for the permitting process. (During the Section 7 consultation, a lighting assessment will likely be needed and light shields put up to limit light pollution and reduce the attractiveness of the installation to fledgling shearwaters.) In-house labor support of 40 hours is not included in this estimate. The natural resources manager may choose to do the initial consultation. If a permit is required, then the natural resources manager would complete the application or an outside contractor hired.

Project Name: Incidental Take Permits		
Affected Facilities	Hickam AFB , Kokee AFS	
Contribution to Management Goals and Objectives	Goal 1, Objective 1 Goal 2, Objective 7 Goal 2, Objective 8 Goal 5, Objective 9	The purpose of this project is to comply with the requirements of the Endangered Species Act and to protect T&E species that may be affected by Air Force activities.
Land Management Units	Hickam AFB—BASH Kokee AFS—Managed Natural Habitat, Landscaped High Maintenance	
Activities and Schedule	For Hickam AFB, implement USFWS recommendations resulting from consultation upon receipt of recommendations. For Kokee AFS, begin Section 7 consultations with USFWS regarding shearwaters, and for bats (if needed). Prepare permit application in 2009; obtain permit by 2010.	
Material and Labor Requirements	Hickam AFB: Natural Resources Manager, 8 hours per week. Kokee AFS: 1 wildlife biologist/environmental scientist or permitting specialist, 180 hours.	

Estimated Cost and Source of Funds	Total: $32,800 (Hickam AFB: $10,800; Kokee AFS: $22,000) ACES-PM, Conservation Resources Funding
Required Outside Agency Consultation	USFWS
Priority with this OCP	Level 1
Impact on Other Projects and on Overall Ecosystem Functions	The Section 7 consultation for Kokee AFS is dependent upon the results of the Monitoring Surveys project (Section 10.2.2.5). This project will help protect the black-necked stilt, coot, moorhen, and koloa populations at Hickam AFB, and the Newell's shearwater and Hawaiian hoary bat populations at Kokee AFS.
Appendix Material	Appendices J and Q

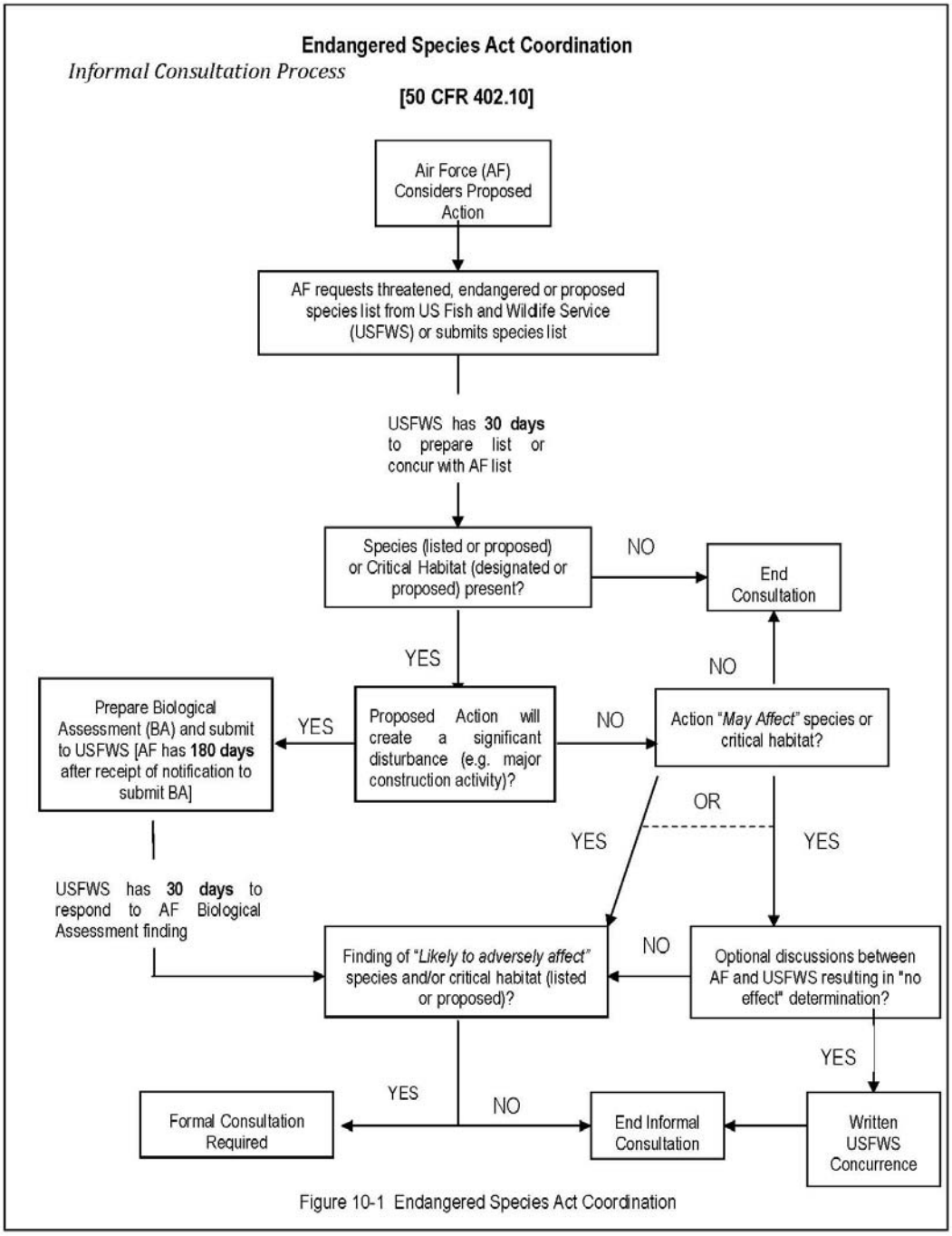

Figure 10-1 Endangered Species Act Coordination

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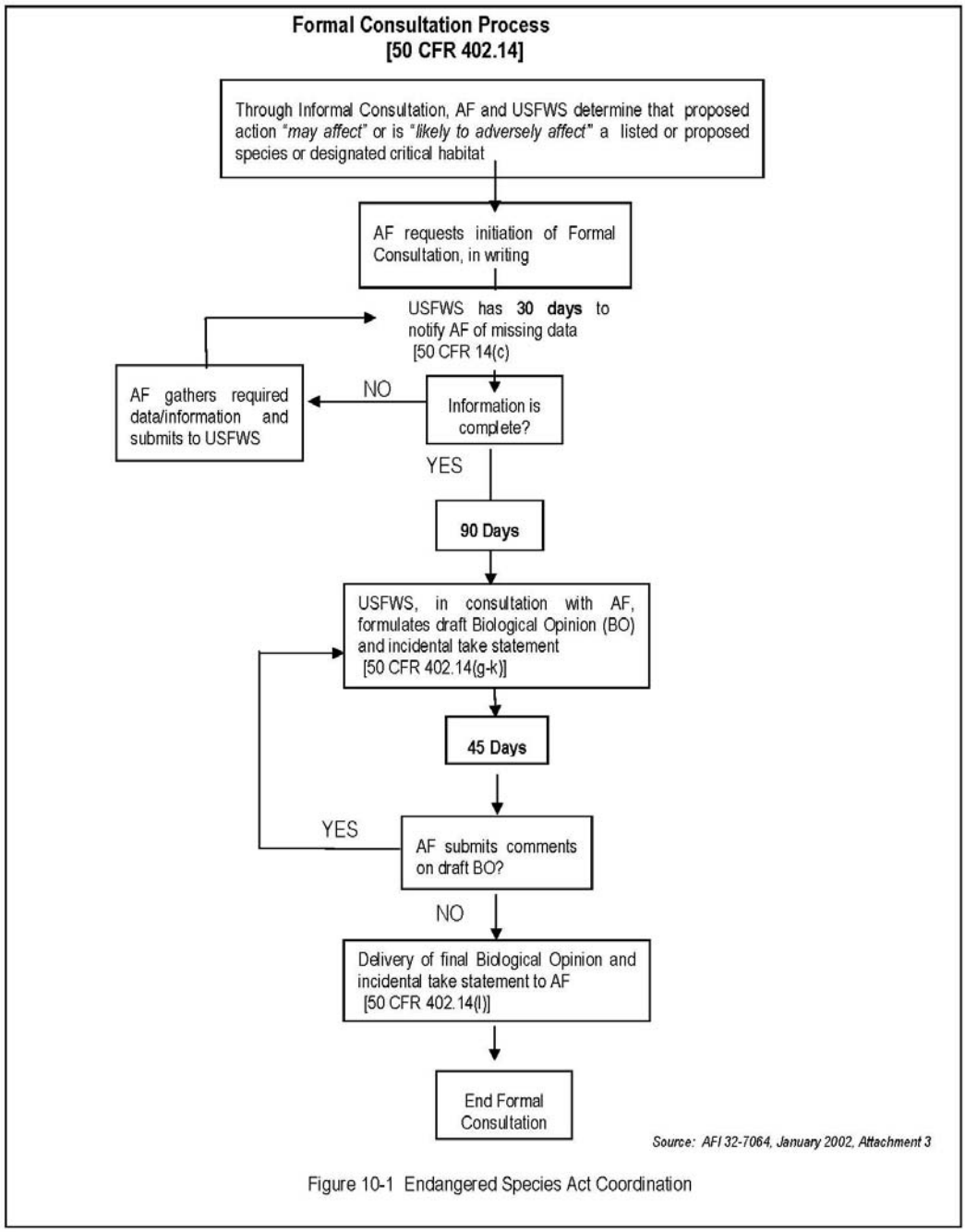


Figure 10-1 Endangered Species Act Coordination

10.2.2.2 Exotic Predator Control

Exotic Exotic predators can severely affect T&E species, particularly birds. Predators are a problem throughout Oahu and Kauai. Installations with identified exotic predator problems, which primarily include Hickam AFB, Bellows AFS, Kaala AFS, and Kokee AFS, will implement a trapping and removal program in coordination with the U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Animal Damage Control (ADC) at Hickam AFB, and with DLNR at the other installations.

Note that, at Hickam AFB, predator control is the joint responsibility of the Entomology, Security Forces, and Natural Resources departments. Feral cats and other nuisance pests around facilities and non-privatized housing are the responsibility of Entomology and/or Security Forces, while the USDA is contracted to control rats, cats, mongoose, and dogs in "natural" areas where wildlife may be threatened. Coordination between Entomology and Natural Resources should be ongoing for possible overlap concerns. The Pest Management Plan (Appendix P) should be consulted for methods on controlling nuisance pests/predators, and "no feeding cats" signs (see Appendix R) should be distributed to facilities managers on an semi-annual basis. Also, a Microsoft Office PowerPoint slide of the "no feeding cats" sign has been inserted in the facility manager briefing presentation, which is given monthly in 15 CES/CEV to new facility managers. An environmental planning representative, usually the NEPA manager, presents at these meetings.

Brown tree snakes (*Boiga irregularis*) have devastated the native bird populations on Guam, and the potential for similar impacts on the Hawaiian Islands is possible should a population become established. Hickam AFB will cooperate with DLNR and USDA in establishing search protocols and developing a plan for trapping brown tree snakes if they are sighted. Searches for brown tree snakes within Air Force cargo planes arriving from Andersen AFB, Guam, will be continued. Furthermore, a system should be considered for tracking cargo from Andersen AFB that may have other intermediate waypoints. Base personnel will be educated about the risk of brown tree snake introductions through the Natural Resources Web Page and by specific education of cargo handlers.

Brown tree snake

The cost estimate for this project is based on an effort of 15 hours per week (or 38% of a $54,000 annual salary) for an assistant natural resources manager, plus $9,600 for equipment and personnel training.

Project Name: Exotic Predator Control		
Affected Facilities	All	
Contribution to Management Goals and Objectives	Goal 1, Objective 1 Goal 2, Objective 2 Goal 2, Objective 5 Goal 5, Objective 3 Goal 5, Objective 6 Goal 5, Objective 9	The purpose of this project is to reduce predation on native species by exotic species such as mongoose, pig, feral cats and dogs, and brown tree snakes using a trapping and hunting program and measures to avoid unwanted introductions (see note).
Land Management Units	Manage Natural Habitat Natural Resources Multiple Use Bird-Aircraft Strike Hazard Reduction	
Activities and Schedule	Develop scope of work by 2010 (see note); implement by 2012.	
Material and Labor Requirements	Assistant Natural Resources Manager, 15 hours per week.	
Estimated Cost and Source of Funds	$28,500 annually ACES-PM, Conservation Resources Funding	
Required Outside Agency Consultation	Coordinate activities with the USFWS, APHIS-ADC, and Hawaii DLNR.	
Priority with this OCP	Level 2	
Impact on Other Projects and on Overall Ecosystem Functions	This project should improve the health of native wildlife populations and help to reduce the threat of future exotic species introductions.	
Appendix Material	Appendices P, R	
Notes: Hunting by the public will not be permitted at Hickam AFB and Bellows AFS, but can be conducted by natural resource management personnel or their contractors hired for the specific purpose of predator removal.		

Confer with the USFWS, APHIS-ADC, and DLNR during development of the program to coordinate effort and to determine effective trapping methodologies and hunting strategies.

10.2.2.3 Ahua Reef Cleanup

Green sea turtles, a species listed as threatened, are regularly observed foraging and resting offshore of Hickam AFB and Bellows AFS. Ghost fishing gear, and in particular abandoned monofilament gillnets, are known to entangle green sea turtles, potentially drowning them. Annual cleanup of Ahua Reef at Hickam AFB will reduce the presence of ghost fishing gear. A full description of this project can be found in Section 10.10.2.2 Ahua Reef Cleanup Project.

10.2.2.4 Natural Resources Web Page

An important component to T&E species conservation is education. Development of an illustrated Internet Natural Resources Web Page, as a part of the existing web site managed by the Public Affairs Office (and accessible to base personnel), and companion library reference book can educate base personnel and the public about what T&E species are present on the Hawaiian Islands, the habitats they live in, and procedures to follow if individuals are found injured or lost. This project can be implemented as part of public outreach and primary or secondary school programs.

The cost estimate for this project is based on an hourly rate of $90 for a computer specialist, and an annual salary of $54,000 for the assistant natural resources manager.

10.2.2.5 Monitoring Surveys

All Installations

Lists of T&E species have been developed for the installations as part of this INRMP. However, continued monitoring at all installations is necessary to determine if other T&E species have begun to utilize any of the installations or if current use is increasing or decreasing. The Monitoring Surveys Project is designed to meet this need for T&E and other plant and animal species.

Monitoring surveys for Hickam AFB and Bellows AFS are currently being conducted by the natural resource manager, supplemented with data from USDA BASH control personnel. (The 15 AW should consider coordinating with MCBH on similar monitoring/surveys taking place on MCTAB.) Survey methods are in accordance with DLNR bi-annual waterbird survey. Survey forms, waterbird photo ID guide, and survey route maps for Hickam AFB and Bellows AFS are provided in Appendix S.

Monitoring surveys are also conducted at the other 15AW installations on a periodic basis by the natural resources manager. Results of the most recent plant surveys conducted at Kaala AFS and Kokee AFS are discussed in Section 10.6.2.1, Control of Invasive Plant Species. Monitoring survey reports are on file at 15 CES/CEVP.

Kokee AFS

Personnel at Kokee AFS have reported finding Newell's shearwaters on the ground at the installation (EA 1996f). Grounded birds are turned over to DLNR, which has an active program to rehabilitate injured birds. A monitoring survey specifically focused on the shearwaters is proposed to determine the cause of the fallout and recommend actions that can be taken to minimize impacts to the species.

The Hawaiian hoary bat is commonly seen at Kokee AFS and has been previously reported to occur at the installation. Recent studies have concluded that electromagnetic radiation can exert an aversive behavioral response in bats. To determine whether the electromagnetic field from the installation's radar dome impacts the bats, a monitoring survey of the bats is proposed. This project should include literature search, investigation of

background electromagnetic radiation field around the radome, and use/avoidance of the area by the bats.

The cost estimate for this project is based on hourly rates of $120 for the wildlife biologist and $72 for the biological technician. It is assumed that one two-night trip during the shearwater's breeding season will suffice to assess whether a flight corridor exists over the installation. Note that the surveys of the shearwaters and bats could be conducted simultaneously.

Project Name: Monitoring Surveys		
Affected Facilities	Kokee AFS	
Contribution to Management Goals and Objectives	Goal 2, Objective 2 Goal 2, Objective 3 Goal 5, Objective 8	The purpose of this project is to better understand the behavior of the Newell's shearwater and the Hawaiian hoary bat, and their utilization of Kokee AFS.
Land Management Units	Managed Natural Habitat Landscape--High Maintenance	
Activities and Schedule	Develop Survey Plan and complete in 2008; complete survey in 2009.	
Material and Labor Requirements	Material: Ornithological radar, bat detector Labor: 1 wildlife biologist and 1 biological technician, 300 hours .	
Estimated Cost and Source of Funds	$50,000 ACES-PM, Conservation Resources Funding	
Required Outside Agency Consultation	None.	
Priority with this OCP	Level 1	
Impact on Other Projects and on Overall Ecosystem Functions	The survey results may impact the Kokee AFS portion of the Incidental Take Permits Project (Section 10.2.2.1).	
Appendix Material	None	

10.2.2.6 Black-necked Stilt Radiotracking

Habitat enhancement opportunities at Hickam AFB for the black-necked stilt are limited due to a potential conflict with BASH management. A Black-necked Stilt Radiotracking Project is proposed to determine if some areas of Hickam AFB are suitable for enhancement without added BASH risk. Of concern is the flight pattern and destination of the stilts that forage at Hickam AFB and whether their flights are likely to conflict with runway approach and take-off zones.

The cost estimate for this project is based on hourly rates of $120 for the wildlife biologist and $72 for the biological technician. The technician would perform the majority of the actual tracking in the field. Coordination with USFWS and DLNR is required.

Project Name: Black-necked Stilt Radiotracking		
Affected Facilities	Hickam AFB	
Contribution to Management Goals and Objectives	Goal 2, Objective 2 Goal 2, Objective 3 Goal 5, Objective 7	The purpose of this project is to better understand the behavior of the black-necked stilt, their utilization of Hickam AFB, and risk of BASH.
Land Management Units	Watercourse and Natural Resource Multiple Use	
Activities and Schedule	Develop Scope of Work by end of 2011; complete study by end of 2012.	
Material and Labor Requirements	Material: Radiotracking equipment Labor: 1 wildlife biologist and 1 biological technician, 1,500 hours (see note).	
Estimated Cost and Source of Funds	$112,500 (see note) ACES-PM, Conservation Resources Funding	
Required Outside Agency Consultation	USFWS, DLNR	
Priority with this OCP	Level 3	
Impact on Other Projects and on Overall Ecosystem Functions	This project could help in the development of habitat enhancement and BASH control strategies for this species. This study may be useful in obtaining an Incidental Take Permit.	
Appendix Material	None	
Notes: This project may be conducted cooperatively by the USAF, USFWS, DLNR and the University of Hawaii. This approach could include cost sharing which could result in expanded project scope and reduced cost for each participating group. Application for state and/or federal grants should be considered.		

10.3 WETLANDS OPERATIONAL COMPONENT PLAN

The purpose of the wetlands operational component plan is to identify policies and propose projects that protect wetlands and enhance wetland functions. This plan supports the basic mission of the base by promoting good stewardship of publicly held lands, and by preserving natural areas for use by wildlife and base personnel.

Federal Wetlands Regulatory Framework

Wetlands located on federally-owned land primarily come under the jurisdiction of the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (USACOE). The most relevant federal policies regarding wetlands are Executive Order 11990, Protection of Wetlands (42 U.S.C. 4321) and Sections 401 and 404 of the Federal Water Pollution Control Act (Clean Water Act, 33 U.S.C. 1341, 1344).

Executive Order 11990 establishes wetland protection as the official policy of all federal agencies, including the Department of Defense. Agencies are

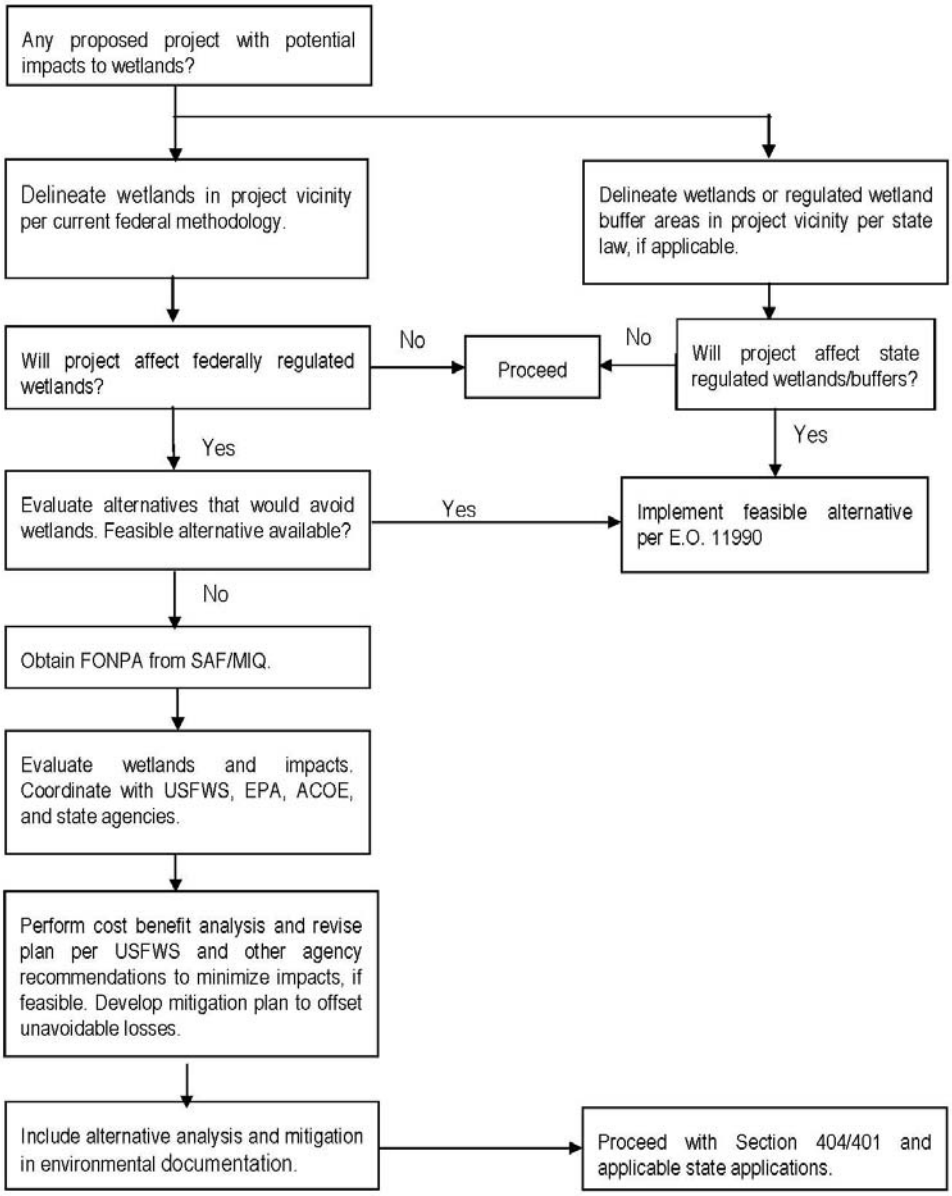


Figure 10-2 Wetland Permitting Process

required under the order to provide leadership and take action to minimize the destruction, loss, or degradation of wetlands affected by a federal project or by any project that receives federal funding. Federal agencies are directed to enhance the natural values of wetlands where possible.

Section 401 of the Clean Water Act is administered by the EPA and requires applicants for federal licenses or permits who propose activities that may result in a pollutant discharge into certain wetlands to obtain a water quality certification for the project from the state in which the work is located. Each state water pollution control agency has the authority to administer Section 401.

Section 404 of the Clean Water Act is administered by the USACOE, which oversees the permit process for projects that involve the fill or dredging of jurisdictional wetlands. Guidance on mitigation requirements under Section 404 is provided by a Memorandum of Agreement between the EPA and the USACOE. The wetland permitting process is shown in Figure 10-2. A copy of the Section 404 permit application form and accompanying questionnaire are provided in Appendix T.

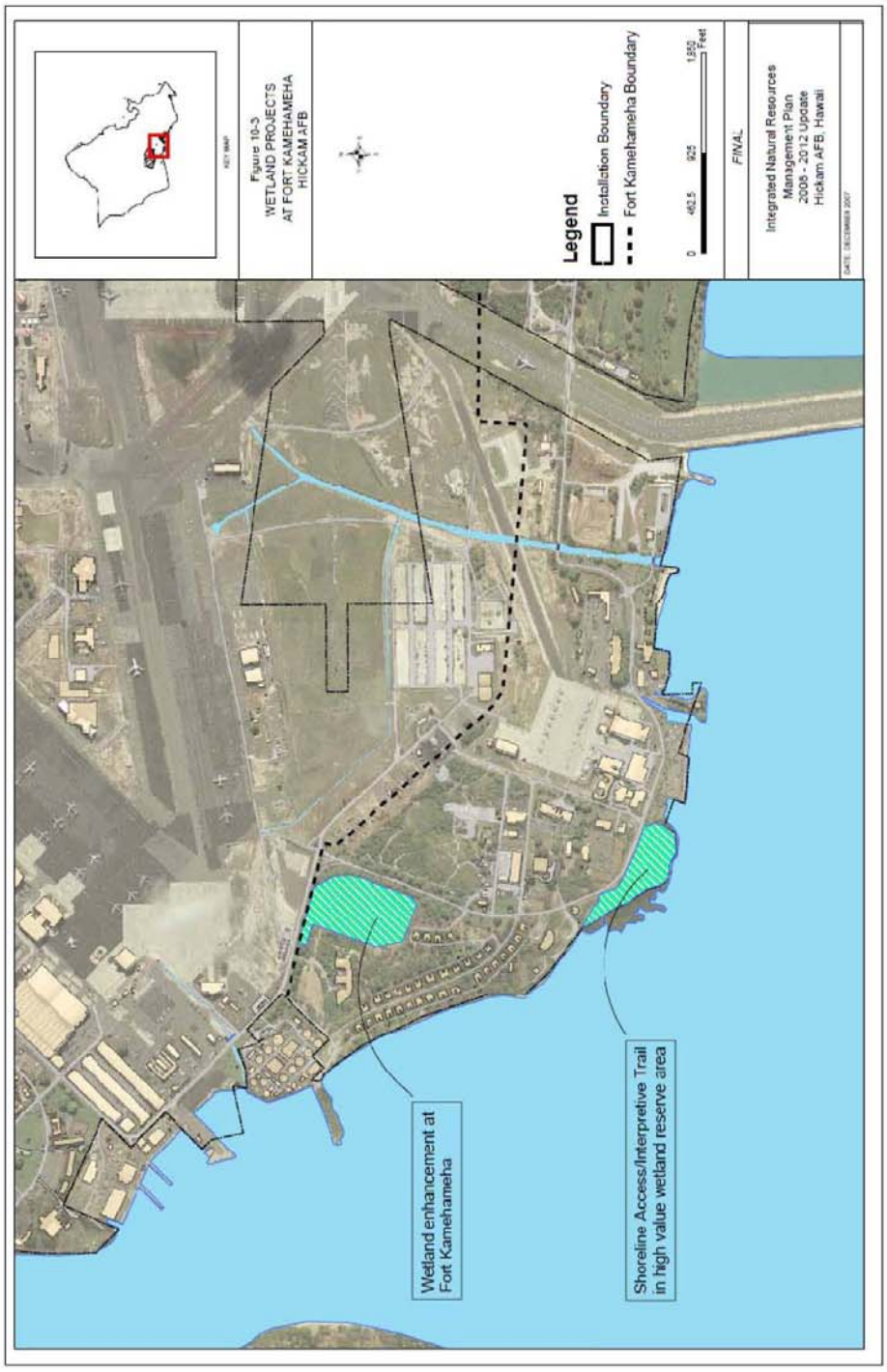
For regulatory purposes, wetlands are classified as either jurisdictional or non-jurisdictional. Jurisdictional wetlands, as defined by the *Corps of Engineers Wetlands Delineation Manual* (USACOE 1987), are:

"those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."

To qualify as a wetland under the criteria in the USACOE manual, an area, under normal circumstances, must display indicators of all three of the following parameters: (1) supports predominantly hydrophytic plant species, at least periodically, (2) the substrate is undrained hydric soil, and (3) the soil is saturated or inundated at some time during the growing season, typically for a period greater than 2 weeks. The jurisdictional definition and criteria are used by the EPA and the USACOE for administering Sections 401 and 404 of the Clean Water Act.

Non-jurisdictional wetlands are not so narrowly defined and are not regulated under the permit system of Section 404 of the Clean Water Act, although coastal management regulations may apply in some cases. Non-jurisdictional wetlands are those that display a positive indicator of any one of the three major wetland parameters but do not meet the full criteria used to determine jurisdictional wetlands. National Wetlands Inventory (NWI) maps include both jurisdictional and non-jurisdictional wetlands.

The following section summarizes the objectives and implementation activities that support Goal 3 and direct future wetlands management practices on lands managed by 15 AW. The summary is followed by operational component plan projects.



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10.3.1 Implementation Summary for Wetlands

Goal 3: Protect wetlands under the jurisdiction of the U.S. Army Corps of Engineers from loss or degradation to the maximum extent possible compatible with the military mission.

Table 10.3-1 summarizes how each objective is to be implemented.

TABLE 10.3-1 IMPLEMENTATION SUMMARY FOR WETLANDS

Implementation Process	Project/Action	Report Section	Applicable Installations
Objective 3.1 : Identify where jurisdictional and non-jurisdictional wetlands occur on Air Force lands, assess their functional value, and manage based on their value as resources.			
Consult INRMP Resource Inventory Reports and GIS for current inventory of wetlands.	1. Implement Permanent Wetland Database Project.	10.3.2.3	Hickam AFB Bellows AFS Kipapa FSA Kaala AFS
Assess functional value of existing wetlands, annually evaluate and manage wetlands, and enhance wetlands.	1. Implement Permanent Wetland Database Project.	10.3.2.3	Hickam AFB Bellows AFS Kipapa FSA Kaala AFS
	2. Implement Long-term Monitoring Project.	10.3.2.4	Hickam AFB Bellows AFS Kipapa FSA Kaala AFS
Coordinate enhancement projects with IRP cleanup projects.	1. Implement Wetland Enhancement at Fort Kamehameha Project.	10.3.2.5	Hickam AFB
Objective 3.2 : Plan military and recreational activities so that impacts to wetlands are minimized or avoided. Develop environmental education programs and signage to protect wetlands in areas where established trails exist. Improve trails or other facilities where needed, to reduce impacts to wetlands.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Coordinate with military operations and base planning to include wetlands information.	1. Implement Permanent Wetland Database Project.	10.3.2.3	Hickam AFB Bellows AFS Kipapa FSA Kaala AFS
	2. Implement Long-term Monitoring Project.	10.3.2.4	Hickam AFB Bellows AFS Kipapa FSA Kaala AFS
	3. Implement Shoreline Access/ Interpretive Trails Project.	10.8.2.2	Hickam AFB Bellows AFS
Objective 3.2 : Plan military and recreational activities so that impacts to wetlands are minimized or avoided. Develop environmental education programs and signage to protect wetlands in areas where established trails exist. Improve trails or other facilities where needed, to reduce impacts to wetlands.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**

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Allow only low-impact recreational and training activities (i.e., foot traffic only, no vehicles) in wetlands.	1. Implement Trail Impact Monitoring and Maintenance Program.	10.8.2.2	Hickam AFB Bellows AFS
	2. Include wetlands education material on Natural Resources Web Page.	10.2.2.4	Hickam AFB Bellows AFS Kipapa FSA Kaala AFS
	3. Exclude paintball from Prime BEEF training area wetlands.	10.8.2.3	Hickam AFB
	4. Implement Evaluation of Section 404 Permit Requirements for Training in Prime BEEF Wetlands Project.	10.3.2.1	Hickam AFB
	5. Exclude high-impact training activities from wetlands.	9.2.5	Hickam AFB
Objective 3.3 :	**Whenever filling of jurisdictional wetlands is necessary on Air Force lands for mission requirements, obtain a Section 404 permit (and the required Section 401 certification which allows the 404 permit to proceed) from the USACOE.**		
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Obtain appropriate Section 401 certification and Section 404 permits from the USACOE as required.	1. Implement Evaluation of Section 404 Permit Requirements for Training in Prime BEEF Wetlands Project.	10.3.2.1	Hickam AFB
	2. If alterations to stream or wetlands are necessary, obtain permits as required.	None	Bellows AFS Kipapa FSA Kaala AFS
Objective 3.4 :	**Whenever possible, incorporate wetland enhancement, restoration, or creation into habitat enhancement plans and into site reconstruction plans following hazardous waste remediation and closure of Installation Restoration Program sites.**		
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Improve wetland habitat.	1. Implement Wetland Enhancement at Fort Kamehameha Project.	10.3.2.4	Hickam AFB
	2. Implement High-value Wetland Reserve Area Restoration Project.	10.3.2.5	Hickam AFB
	3. Implement Wetland Restoration at Bellows AFS Oxbow Project.	10.3.2.6	Bellows AFS
Investigate wetland enhancement opportunities as part of the Installation Restoration Program.	1. Receive IRP site closure plans for incorporation of wetland enhancement, restoration, or creation measures.	Appendix B	Hickam AFB Bellows AFS Kipapa FSA Kaala AFS
Objective 3.5 :	**Utilize wetlands as part of water quality improvement programs. Any use of wetlands for treatment of water with contaminants or high nutrient loads should utilize constructed wetlands, whereas water quality improvement of natural wetlands should be incorporated into watershed management plans.**		
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**

Coordinate with base engineers and planners responsible for flood control/stormwater management.	1. Consider development of a constructed wetland to treat runoff from urban activities or IRP sites.	None	Hickam AFB
Consider watershed improvements at Bellows AFS to enhance natural wetlands.	1. Implement Watershed Assessment Project.	10.4.2.2	Bellows AFS

10.3.2 Operational Component Plan Projects

The Air Force establishes wetland management policy for Air Force lands in AFI 32-7064. This Instruction states that Air Force policy is to avoid locating new construction in wetlands unless:

1. there are no practicable alternatives;
2. plans for the proposed action include all practicable measures to minimize wetland impacts; and
3. potential impacts have been analyzed in the appropriate environmental impact analysis process.

In evaluating the existence of practicable alternatives, the Air Force considers mission, economic, environmental, and other pertinent factors. A Finding of No Practicable Alternative (FONPA) must be signed by the proper Air Force authority before actions in the wetland can proceed. Air Force policy requires that installations comply with state and local wetland protection laws, as well as with Sections 401 and 404 of the Clean Water Act (AFI 32-7064, Sections 3.3.1 and 3.3.2). Only low-impact training and recreational activities will be allowed in wetlands in the form of foot traffic. All vehicular traffic will be prohibited in jurisdictional wetlands.

To plan for long-term protection or mitigation of wetlands, Air Force installations are required to maintain current inventories of wetlands and to classify wetlands in a manner consistent with the NWI (AFI 32-7064, Section 3.4), which uses the USFWS system (Cowardin et al. 1979). Jurisdictional delineations, as defined by the USACOE (USACOE 1987), must be conducted for wetlands occurring within proposed project sites.

In the process of preparing this INRMP, wetlands on lands managed by 15 AW were inventoried, categorized as jurisdictional or non-jurisdictional, and further classified using the USFWS system. These wetlands occur primarily in the Watercourse and Natural Resources Multiple Use MEAs at Hickam AFB, Bellows AFS, and Kipapa FSA. However, a small portion of a high value bog wetland at Kaala AFS occurs in the Managed Natural Habitat MEA. (See Figures 7-1A [Hickam AFB], 6-2C and 6-2D [Bellows AFS], 7-3A [Kipapa FSA], and 7-4 [Kaala AFS] for location of the wetlands.) Where possible, boundaries were drawn to include wetlands in MEAs where the primary management emphasis is on protection of the natural resources. At Bellows, there are jurisdictional wetlands along Waimanalo Stream that fall within both Bellows AFS and MCTAB property boundaries (Ching 2002). Any wetland identification and mitigation projects at Bellows AFS should be coordinated with MCBH whose INRMP has related wetland projects programmed (Drigot and Duin 2006).

This plan includes six projects which are designed to protect wetlands and improve management of wetland ecosystems. Of these, one O&S project is first priority and should be accomplished by 2008. The Level 1 project should begin in 2008 with annual updates through 2012. The Level 2 project is projected for the 2009-2012 period. The Level 3 projects are planned to begin in 2010. The following projects help to implement Goal 3 objectives:

- O&S
  - Evaluation of Section 404 Permit Requirements for Training Activities in Prime BEEF Wetlands
- Level1
  - Permanent Wetland Database
- Level 2
  - Long-term Monitoring of Wetland Functions
- Level 3
  - Wetland Enhancement at Fort Kamehameha
  - High-value Wetland Reserve Area Restoration
  - Wetland Restoration at Bellows AFS Oxbow

10.3.2.1 Evaluation of Section 404 Permit Requirements for Training Activities in Prime BEEF Wetlands

Training activities in the Prime BEEF area at Hickam AFB occur adjacent to wetlands in canals/drainage ditches bordering the training area, and may sometimes occur within the wetlands themselves. Potential wetland impacts associated with these training activities will be assessed by a wetland biologist and consultation with the USACOE undertaken. The USACOE will determine whether or not a Section 404 permit is warranted. Although Section 404 permits are typically associated with dredging or filling of wetlands, wetland filling could be loosely interpreted by the USACOE to include sediment input into wetlands from erosion along the canal walls due to heavy foot or vehicular traffic. The State of Hawaii should also be consulted regarding the need for a Section 401 water quality certification. This project will ensure compliance with Section 401 and 404 requirements and help to mitigate potential impacts from training activities.

The cost estimate for this project is based on a projected hourly rate of $120 for a wetland biologist. The initial estimate of $1,200 is to cover initial agency consultation to determine if a permit is required. If required, the estimate is for an additional $6,600.

Project Name: Evaluation of Section 404 Permit Requirements for Training Activities in Prime BEEF Wetlands		
Affected Facilities	Hickam AFB	
Contribution to Management Goals and Objectives	Goal 1, Objective 1 Goal 3, Objective 2 Goal 3, Objective 3	The purpose of this project is to ensure Section 401 and 404 compliance for training activities occurring in the ditched wetland in the Prime BEEF area.
Land Management Units	Watercourse Intensive Training	

Activities and Schedule	Consult with USACOE on activities conducted in the wetland; apply for wetland permit if necessary; delineate wetland.
Material and Labor Requirements	Wetland biologist – 10 hours to consult with USACOE, 50 hours to delineate wetland and write wetland report.
Estimated Cost and Source of Funds	$1,000 without permit; $5,500 with report/permit application ACES-PM, Conservation Resources Funding
Required Outside Agency Consultation	Consultation and possible permit process with USACOE. Consultation with DLNR recommended.
Priority with this OCP	O&S
Impact on Other Projects and on Overall Ecosystem Functions	Project will result in mitigating potential wetland impacts from training.
Appendix Material	None

10.3.2.2 Permanent Wetland Database

The purpose of maintaining an annually updated, permanent database that includes all pertinent information on wetlands is that it enables managers to easily integrate installation planning with wetland protection. Potential wetland impacts will be more easily predicted and avoided in the early planning stages of development projects.

A wetland database was established with the resource inventories that were conducted for this INRMP. The database currently includes information on the following: wetland location and size, jurisdictional status, NWI classification, dominant plant species, soil types, typical hydrologic regime, and management emphasis area. This information is in a computer format that links the data to the mapping polygons that were digitized using the GeoBase. Additional information on the wetlands can be obtained from the resource inventory reports developed for this INRMP (EA 1996a, b, c, d, e, f, g). Within this INRMP, wetland locations are shown on Figures 7-1A, 6-2C and 6-2D, 7-3A, and 7-4 for Hickam AFB, Bellows AFS, Kipapa FSA, and Kaala AFS, respectively. (There are no wetlands on Waikakalaua FSA or Kokee AFS.)

Existing information on wetlands will be supplemented as new data are collected. Additional types of information that could be entered into the database include: changes to vegetative cover or plant community composition, water quality and quantity monitoring data, dates and descriptions of management actions occurring in and adjacent to wetlands, changes in wetland functions, and other relevant information. Potential sources of data for additional entries to the database include the annual wetland function monitoring program, Section 404 permit applications, water quality monitoring data, and the DLNR database (Mt. Kaala Natural Area Reserve).

A *Vegetation Mapping and Monitoring Plan of Shoreline Wetland and Sand Beach, Fort Kamehameha, Hickam Air Force Base, Oahu, Hawaii, May 2002*, prepared by the U.S. Army Corps of Engineers, Honolulu Engineer District, Hawaii, depicted on a map, major vegetation types, with special attention to mangrove (as an invasive species) and shoreline strand vegetation as a

desirable "hedge" to erosion. This study also provided the results of a literature review and descriptions with pictures of each species of major vegetation. In addition, this study determined what monitoring is necessary for invasive and beneficial communities to include permanent data points in those communities for annual evaluation. The scope of this project was limited to the coastal wetland and shoreline area at Fort Kamehameha (15 ABW 2002).

A report entitled *Wetlands of MCBH, Island of Oahu, Hawaii*, September 2002, prepared for MCBH by the U.S. Army Corps of Engineers, Honolulu District mapped wetlands at Bellows, finding two wetlands that could be classified as jurisdictional under the criteria of the Clean Water Act administered by the US Army Corps of Engineers (Ching 2002). The lower Waimanalo Stream wetland is primarily within Bellows AFS boundaries, while the upper Waimanalo Stream wetland is on MCTAB property. Information from this report should be added to the wetland database. Future updates to the wetland database for Bellows AFS should be coordinated with MCBH.

AFI 32-7064 requires development and maintenance of current inventories of NWI wetlands. Known or suspected jurisdictional wetlands should be delineated according to USACOE standards if an action is to be undertaken that may affect the wetlands.

The cost estimate for this project is based on projected hourly rates of $120 for a wetland biologist and $108 for a database manager.

Project Name: Permanent Wetland Database		
Affected Facilities	Hickam AFB, Bellows AFS, Kipapa FSA, Kaala AFS	
Contribution to Management Goals and Objectives	Goal 3, Objective 1 Goal 3, Objective 2	The purpose of this project is maintain an up-to-date, permanent database that includes information on all wetlands occurring on lands managed by 15 AW.
Land Management Units	Manage Natural Habitat Watercourse Natural Resources Multiple Use Intensive Training Bird Aircraft Strike Hazard Reduction	
Activities and Schedule	Enter additional data on wetlands into computer spreadsheet or database; integrate additional data from habitat functions monitoring, Section 404 permits, and other sources; link database to GeoBase if possible; establish database by 2008.	
Material and Labor Requirements	Expanding Database: wetland biologist – 80 hours Database manager – 80 hours. Annual Database Updates: database manager – 40 hours.	
Estimated Cost and Source of Funds	Expanding Database: $18,240; Annual Database Updates : $4,320 ACES-PM, Conservation Resources Funding	
Required Outside Agency Consultation	None, although coordination with MCBH is recommended.	
Priority with this OCP	Level 1	
Impact on Other Projects and on Overall Ecosystem Functions	Positive impacts on wetland and wildlife management; will minimize negative wetland impacts from base development and mission activities.	
Appendix Material	None	

10.3.2.3 Long-term Monitoring of Wetland Functions

Wetlands are of value to ecosystems in performing functions such as maintaining water quality and providing unique habitat for wildlife. Wetlands also have values more directly related to human use, such as flood control and recreation. Wetland functions can be evaluated on a qualitative basis as to how well each wetland performs basic hydrologic, water quality, and biological functions, or they can be evaluated on a more quantitative basis. The evaluation of each of these functions considers the hydrologic and geomorphic setting in which the wetland occurs, and applies current scientific understanding of the effectiveness of each wetland function.

A qualified wetland biologist should evaluate annually the functions of all wetlands occurring on lands managed by 15 AW. To detect subtle changes in functions and get a relative gage of cumulative impacts, a quantitative model, such as the Wetland Evaluation Technique (WET) (Adamus et al. 1987) or a Hydrogeomorphic Approach adapted for use in Hawaii, is preferable to qualitative estimates. The following functions should be evaluated: wildlife habitat (diversity and abundance estimates), flood abatement, sediment stabilization, sediment retention, nutrient removal/transformation, ground-water recharge/discharge, and recreational value. At a minimum, long-term monitoring of trends in habitat values should be conducted, as this is a requirement of AFI 32-7064 for jurisdictional wetlands.

The cost estimate for this project is based on a projected hourly rate of $120 for a wetland biologist.

Project Name: Long-term Monitoring of Wetland Functions		
Affected Facilities	Hickam AFB, Bellows AFS, Kipapa FSA, Kaala AFS	
Contribution to Management Goals and Objectives	Goal 3, Objective 1 Goal 3, Objective 2	The purpose of this project is to monitor changes in wetland functions over time and to protect against wetland degradation.
Land Management Units	Manage Natural Habitat Watercourse Natural Resources Multiple Use Intensive Training Bird Aircraft Strike Hazard Reduction	
Activities and Schedule	Ongoing annual monitoring to begin in 2009.	
Material and Labor Requirements	Wetland biologist – 100 hours per year.	
Estimated Cost and Source of Funds	$14,400 annually ACES-PM, Conservation Resources Funding	
Required Outside Agency Consultation	None	
Priority with this OCP	Level 2	
Impact on Other Projects and on Overall Ecosystem Functions	Positive impacts on wetland and wildlife management; will be useful for minimizing negative impacts to wetlands.	

10.3.2.4 Wetland Enhancement at Fort Kamehameha

The wetland located south of Fort Kamehameha Road and west of Seaman Avenue is virtually barren and has little value in terms of aesthetic quality or wildlife habitat. Brackish ground water infiltrates the surface layers of the shallow soils, resulting in the formation of a salty surface crust upon evaporation of ponded water (Iwamoto 1996a). Few plant species are able to tolerate such conditions. Sparse patches of pickleweed occur in the northern quarter of the wetland, with kiawe shrubs along the wetland boundary. Figure 10-3 shows the location of this wetland enhancement project along with the high-value wetland reserve that is planned as the site for the Shoreline Access/Interpretive Trails Project (Section 10.8.2.2).

Note that, due to the proximity of this project area to the approaches to Runway 8L, the primary goal of this project is to improve the aesthetics rather than enhancing wildlife habitat. Coordination with FWS and USDA-APHIS is required, to explore and implement options to discourage wetland birds from using the area.

The project goal would be accomplished through establishment of a vegetative cover over approximately 10 acres throughout the wetland and wetland buffer area. Existing kiawe and pickleweed would be removed and replaced with milo, sesuvium, and other coastal native species. A wetland enhancement plan should be developed by a local, qualified wetland biologist and/or botanist. USACOE should be consulted to determine whether a Section 404 permit is required.

The cost estimate for this project is based on the following projected hourly rates: wetland biologist, $120; landscape architect, $120; landscapers, $24; backhoe operator, $48. The estimated cost for plants is $6 for shrubs and $3 for herbaceous species.

Project Name: Wetland Enhancement at Fort Kamehameha		
Affected Facilities	Hickam AFB, south of Fort Kamehameha Road and west of Seaman Avenue	
Contribution to Management Goals and Objectives	Goal 3, Objective 1 Goal 3, Objective 4	The purpose of this project is to establish native vegetation in a 10-acre barren wetland area, thus enhancing aesthetics.
Land Management Units	Natural Resources Multiple Use	
Activities and Schedule	Complete enhancement plan by 2011; implement plan by 2012.	
Material and Labor Requirements	Native plants : herbaceous species planted on 3-foot centers around pond edge – up to 10,000 plants; shrub species planted on 6-foot centers- up to 2,000 plants; backhoe. Soil Amendments: fertilizers, topsoil (up to 7,000 cubic yards). Labor: Wetland biologist – 160 hours; landscape architect – 80 hours; landscapers – 160 hours, backhoe operator – 50 hours.	

Estimated Cost and Source of Funds	$194,200 ACES-PM, Conservation Resources Funding
Required Outside Agency Consultation	USACOE should be consulted whenever planning vegetation clearing in wetlands to confirm compliance with CWA Section 404. FWS and USDA APHIS are to be consulted about BASH control
Priority with this OCP	Level 3
Impact on Other Projects and on Overall Ecosystem Functions	Project will enhance aesthetics of the existing wetland.
Appendix Material	None

10.3.2.5 High-Value Wetland Reserve Area Restoration

The high-value wetland reserve area on Hickam AFB is located at the south end of the installation, bounded by Seaman Avenue to the north and the shoreline of Mamala Bay to the south. This area is planned as the site for the Shoreline Access/Interpretive Trails Project (Section 10.8.2.2). The wetland area includes mangrove-dominated shrublands and sand beaches. A large patch of pickeweed occurs along the northeastern edge of one mangrove area. (Pickleweed is an invasive groundcover shrub that thrives in salt-water inundated and salty soils. It grows in thick mats and precludes other vegetation from growing.) The wetland area is tidally inundated on a regular basis, and a shallow, brackish water table is present.

The goal of this project is to revegetate the area with native species to continue to provide a coastal buffer and minimize erosion. A wetland restoration plan should be developed by a local, qualified wetland biologist and/or botanist. The components of the restoration plan would be as follows:

1. **Full mangrove removal**. See Section 10.4.2.4 Watercourse Conveyance Enhancement for description of typical activities involved in mangrove removal.
2. **Pickleweed control.** Recommend that experirments be conducted to see how best to eradicate a small patch and subsequently eliminate seedling emergence.
3. **Native revegetation.** Several dozen native coastal species are readily available in local nurseries and can be used to supplant the invasive species when they are removed. Recommend that an on-base nursery be set up to more economically propagate native plants (see Section 10.9.1 Outleasing for Native Plant Horticulture).
4. **Erosion control.** The beach at the west end of the wetland area is open to vehicle access, creating unvegetated areas and increasing erosion. Vehicle access should be limited to at least a 20-foot setback from the high water mark. This can be done by clearing vegetation away from the beach in areas currently overgrown with weeds, planting native species along the coastal strip, protecting this strip with fallen kiawe logs, and creating well-marked walking paths reinforced with limestone gravel.
5. **Trail improvements and recreation.** Currently, the wetland area is poorly utilized for walking and jogging. The paths through the area

are mostly overgrown with pickleweed and mangrove, and have several areas of pooled water. Enhancing these paths through vegetation control, soil stabilization, and building of bridges over the pools will enhance the attractiveness of the area to visitors.

6. **Dog restrictions.** Dogs are often observed unleashed along the beach, chasing waterbirds. It should be made base policy to have dogs on leashes at the wetland area.

The cost estimate for this project is based on the following projected hourly rates: wetland biologist, $120; landscape architect, $120; landscapers, $24; excavator operator, $48. The estimated cost for plants is $6 for shrubs and $3 for herbaceous species.

Project Name: High-value Wetland Reserve Area Restoration		
Affected Facilities	Hickam AFB	
Contribution to Management Goals and Objectives	Goal 2, Objective 3 Goal 4, Objective 1 Goal 4, Objective 3 Goal 5, Objective 3 Goal 10, Objective 1	The purpose of this project is to enhance the high-value wetland reserve area on Hickam AFB.
Land Management Units	Natural Resources Multiple Use	
Activities and Schedule	Develop Scope of Work by 2011; complete project by 2012.	
Material and Labor Requirements	Native plants : herbaceous species planted on 3-foot centers – up to 5,000 plants; shrub species planted on 6-foot centers- up to 1,000 plants. Excavator and wood chipper for removal of mangroves. Labor: Wetland biologist, 160 hours; landscape architect, 80 hours; landscapers, 320 hours, excavator operator , 40 hours.	
Estimated Cost and Source of Funds	$50,000 ACES-PM, Conservation Resources Funding	
Required Outside Agency Consultation	USACOE should be consulted whenever planning vegetation clearing in wetlands to confirm compliance with CWA Section 404.	
Priority with this OCP	Level 3	
Impact on Other Projects and on Overall Ecosystem Functions	Plants could be acquired from the Native Plant Horticulture Project. Work should be coordinated with Shoreline Access/InterpretiveTrails project.	
Appendix Material	None	

10.3.2.6 Wetland Restoration at Bellows AFS Oxbow

At Bellows AFS, a mangrove forest dominates the oxbow at Waimanalo Stream (see Figure 6-2D), preventing native wetland species from growing at the site. In December 2006, a mangrove removal project was conducted by an Air Force contractor, which resulted in the removal of 0.739 acre of mangrove forest; previous mangrove removal efforts in 2004 and 2005 cleared an area of approximately 0.062 acre (Tetra Tech 2007). The area cleared so far comprises about one quarter of the total mangrove forest at Bellows AFS. Complete removal of the mangroves is necessary in order to restore the oxbow to its original wetland state. Future removal actions should be conducted in

conjunction with the recommendations of the *MCBH Marine Corps Training Area Bellows Watershed Impairment Study* (Hood et al. 2002).

The goal of this project is to restore wetland functionality as wildlife habitat and stormwater conveyance. A wetland restoration plan should be developed by a local, qualified wetland biologist and/or botanist. The components of the restoration plan would be as follows:

1. **Full mangrove removal**. See notes at bottom of table below for description of typical activities.
2. **Native revegetation**. Native species are readily available in local nurseries and can be used to supplant the invasive species when they are removed. Recommend that an on-base nursery be set up to more economically propagate native plants (see Section 10.9.1 Outleasing for Native Plant Horticulture).
3. **Wetland engineering**. To enhance stormwater storage capacity and create better wildlife habitat, excavation of fill and re-grading of channel bottom and banks will be required. See recommendations of *MCBH Marine Corps Training Area Bellows Watershed Impairment Study* (Hood et al. 2002).

The cost for removal of the remaining mangrove forest at Bellows AFS is based on project costs provided in Tetra Tech's 2007 report, while the wetland engineering portion is based on the 2002 watershed impairment study by Hood et al.

Project Name: Wetland Restoration at Bellows AFS Oxbow		
Affected Facilities	Bellows AFS	
Contribution to Management Goals and Objectives	Goal 2, Objective 3 Goal 4, Objective 3	The purpose of this project is to remove mangroves from the oxbow at Waimanalo Stream to allow growth of native wetland species, and to regrade the channel to enhance stormwater conveyance capability.
Land Management Units	Watercourse	
Activities and Schedule	Develop scope of work by 2009; complete project by 2010.	
Material and Labor Requirements	Materials: Excavator, wood chipper, trucks. Labor: 3 construction laborers, 300 hours each; 1 excavator operator, 40 hours; 1 biologist, 150 hours .	
Estimated Cost and Source of Funds	$187,500 for complete removal of remaining mangroves; $155,500 for wetland engineering. ACES-PM, Conservation Resources Funding	
Required Outside Agency Consultation	USACOE for Section 404 Permit for Clearing Vegetation. Also, recommend coordinating with MCBH when conducting removal at Bellows AFS.	
Priority with this OCP	Level 3	
Impact on Other Projects and on Overall Ecosystem Functions	Must be coordinated with the Riparian Enhancement project (Section 10.4.2.3).	
Appendix Material	None	

Notes:
There are two forms of mangrove removal:

1. Hand removal includes the use of chain saws to remove the tops above the prop roots. Mangroves eventually grow back, and the removal process is repeated.
2. Heavy equipment is used to remove the tops plus the root system. Any such removal in areas of high probability for archaeological resources needs to be coordinated with three Native Hawaiian Groups, because of the likelihood of disturbing subsurface deposits: the Office of Hawaiian Affairs, the Hui Malama I Na Kupuna' O Hawaii Nei, and the Oahu Island Burial Council.

10.4 WATERSHED PROTECTION OPERATIONAL COMPONENT PLAN

Each installation with industrial activity is responsible for managing stormwater runoff from impervious surfaces, and each has prepared or is developing stormwater management and/or pollution prevention management plans. In addition, the Hawaii Department of Health (DOH) is responsible for controlling nonpoint source pollution and for maintaining the safety of drinking water. The DOH, together with the Hawaii Department of Business, Economic Development and Tourism, has developed *Hawaii's Implementation Plan for Polluted Runoff Control* (Hawaii Coastal Zone Management Program 2000).

Watershed protection requires regional management of surface and ground waters, so the Air Force will need to work cooperatively with DOH.

Specific actions for the Air Force are summarized below, including four projects.

10.4.1 Implementation Summary for Watershed Protection

Goal 4: Protect, maintain, and improve water quality in streams, canals, and coastal waters.

Table 10.4-1 summarizes how each objective is to be implemented.

TABLE 10.4-1 IMPLEMENTATION SUMMARY FOR WATERSHED PROTECTION

Objective 4.1 : Enhance the water quality and capacity of streams and canals, and the quality of coastal waters, by reducing the amount of sediment that is released into the system from erosion caused by human activities.			
Implementation Process	**Project/Action**	**ReportSsection**	**Applicable Installations**
Riparian Buffer Zones (RBZ) have been incorporated into the Watercourse MEA.	1. Incorporate these buffers into project planning.	9.2.3	Hickam AFB Bellows AFS Kipapa FSA
Reduce sediment in RBZs.	1. Implement Best Management Practices for water quality protection.	Appendix F	Hickam AFB Bellows AFS Kipapa FSA
	2. Implement the Riparian Enhancement Project.	10.4.2.3	Bellows AFS
	3. Include sediment reduction measures as part of the Trail Monitoring and Maintenance Program.	10.8.2.5	Hickam AFB Bellows AFS
Determine sources and sinks of on- and off-base sediment.	1. Implement Watershed Assessment Project.	10.4.2.2	Bellows AFS

Objective 4.1 : Enhance the water quality and capacity of streams and canals, and the quality of coastal waters, by reducing the amount of sediment that is released into the system from erosion caused by human activities.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Explore cooperative agreements for the reduction of erosion with other landowners sharing watersheds with the AF, and coordinate with the DOH.	1. Same as process.	None	Hickam AFB Bellows AFS Kipapa FSA
	2. Implement the Watershed Assessment Project.	10.4.2.2	Bellows AFS
Objective 4.2 : Reduce the amount of pollutants entering streams, canals, and coastal waters from both off-base and on-base activities and land uses (i.e., from runoff, spills, and littering) where feasible.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Reduce pollutant load on water bodies at Hickam AFB.	1. Implement the Pollution Prevention Plan for Hickam AFB.	None	Hickam AFB
Determine current levels of pollutants entering water bodies.	1. Conduct the Watercourse Sediment Feasibility Study.	10.4.2.1	Hickam AFB
Reduce pollutant load contributed by training activities.	1. Follow BMPs identified for training exercises.	Appendix F	Hickam AFB
Improve water quality by removing visible debris.	1. Garbage collection teams will be deployed on a regular basis (especially following high stream flows) along watercourses to pick up litter.	None	Hickam AFB Bellows AFS Kipapa FSA
Monitor water quality.	1. Each year (or more frequently if possible), obtain all available water quality data collected at each installation. Summarize data and compare with past data to detect water quality changes.	None	Hickam AFB Kipapa FSA
Objective 4.3 : Restore natural stream channels and enhance man-made canals to a more natural and healthy condition than currently exists and to assure adequate function for stormwater conveyance through mitigation projects that may include dredging to remove sediment and selective removal of mangrove.			
Implementation Process	**Project/Action**	**Report section**	**Applicable Installations**
Improve the riparian function along Waimanalo Stream.	1. Implement the Riparian Enhancement Project.	10.4.2.3	Bellows AFS

Investigate the possibility for increasing tidal flux, water conveyance, and water quality.	1. Implement the Watercourse Sediment Removal Feasibility Study, and then follow through with study recommendations.	10.4.2.1	Hickam AFB
Increase water conveyance within canals on Hickam AFB and within Inoa'ole Stream at Bellows AFS.	1. Implement the Watercourse Conveyance Enhancement Project.	10.4.2.4	Hickam AFB Bellows AFS
Objective 4.4 : Manage stormwater flow and runoff from the installation to avoid or minimize impacts on off-site land uses and cultural resources.			
Implementation Process	**Project/Action**	**Report section**	**Applicable Installations**
Management of stormwater flow and runoff with sensitivity to off-site land uses and cultural resources can only be accomplished with thorough knowledge of their location and type.	1. Consult the cultural resources program manager and management plans.	None	Hickam AFB Bellows AFS Kipapa FSA Kaala AFS Kokee AFS
	2. Include off-site land uses and cultural resources investigation as part of the Watercourse Sediment Removal Feasibility Study Project.	10.4.2.1	Hickam AFB
	3. Include cultural resources investigation as part of an expanded Watershed Assessment Project.	10.4.2.2	Bellows AFS

10.4.2 Operational Components Plan Projects

The Operational Component Plan for Watershed Protection includes contributions from four projects that are designed for implementation primarily at Hickam AFB and/or Bellows AFS. Of these proposed projects, one O&M is first priority (to be accomplished by 2009) and Levels 2 and 3 are second priority (to be accomplished by 2012) along with one project with an unassigned funding level. Furthermore, all of the projects were specifically designed to reach Goal 4 objectives, but they also contribute to meeting other goals and objectives.

The following projects help to implement Goal 4 objectives:

- O&M
  - Watercourse Conveyance Enhancement
- Level 2
  - Watershed Assessment
- Level 3
  - Riparian Enhancement
- Unknown
  - Watercourse Sediment Removal Feasibility Study

10.4.2.1 Watercourse Sediment Removal Feasibility Study

The Watercourse Sediment Removal Feasibility Study is for management of watercourses at Hickam AFB. This study will determine the current level of hazardous materials within sediments found in the watercourses and provide managers with sufficient information to determine if rehabilitation and cleanup projects are warranted. Cleanup projects may include dredging and removal of contaminated sediments, which would require a permit from the USACOE and construction oversight from an archaeologist to ensure that the removal activity would not disturb Native Hawaiian remains or artifacts.

However, several important unknowns need clarification prior to implementing a sediment removal project. These include:

- Determine the level of hazardous waste contamination within the streams and canals (both extent and concentration of contaminants);
- Review the currently available removal methods;
- Assess the associated risks for hazardous waste release for different removal methods;
- Determine the costs associated with different removal methods; and
- Determine the disposal location of sediment spoils material following removal.

The cost estimate assumes labor rates of $120/hr for engineers and $48/hr for technicians.

Project Name: Watercourse Sediment Removal Feasibility Study		
Affected Facilities	Hickam AFB	
Contribution to Management Goals and Objectives	Goal 2, Objective 3 Goal 4, Objective 2 Goal 4, Objective 3 Goal 4, Objective 4 Goal 5, Objective 3 Goal 10, Objective 1	The purpose of this project is to determine the level of hazardous chemical contamination in sediments found in the streams and canals, evaluate alternative methods for safe sediment removal with minimal release of entrained wastes, and develop a plan and budget estimate for sediment removal and subsequent disposal.
Land Management Units	Watercourse MEA Hickam AFB: Manuwai and Kumumau'u Canals	
Activities and Schedule	Complete study in 2009.	
Material and Labor Requirements	Materials : Sample Collection Equipment, Chemical Analyses ($2,400). Labor : 2 engineers, 300 hours; 1 technician, 200 hours.	
Estimated Cost and Source of Funds	$98,400 IRP Funds	

Required Outside Agency Consultation	USACOE
Priority with this OCP	Not Available
Impact on Other Projects and on Overall Ecosystem Functions	This project should be coordinated with the Watercourse Conveyance Enhancement Project.
Appendix Material	None

10.4.2.2Watershed Assessment Project

The Watershed Assessment Project is designed to provide the additional information needed to improve water quality in Waimanalo Stream, which runs along the southern boundary of Bellows AFS, and Inoa'ole Stream. The Watershed Assessment Project is designed to learn the on-base sources and sinks of sediment and pollution within both stream basins. The results of this project will provide the natural resource manager with guidance for creating constructive cooperative agreements with other basin landowners and DOH to reduce pollution and sediment load in the streams resulting from human activities.

A related issue is the capacity of the streams to handle floodwaters generated upstream as well as runoff from the installation. The adequacy of the streams to handle floodwaters should be considered during a regional flood management study based in part on new mapping by FEMA, although no specific project for the Air Force is included in this INRMP. The Watershed Assessment Project could be expanded to include water quantity as well as quality evaluations, but the recommended project focuses on sediment and pollutants.

Labor rates used in the cost estimate, which includes preparation of a report are: fluvial geomorphologist, $108/hr; water quality specialist, $96/hr; technician/clerical, $48/hr.

Project Name: Watershed Assessment		
Affected Facilities	Bellows AFS	
Contribution to Management Goals and Objectives	Goal 3, Objective 5 Goal 4, Objective 1 Goal 4, Objective 2 Goal 4, Objective 4 Goal 5, Objective 3 Goal 10, Objective 1	The purpose of this study is to identify the sources and sinks of on-base sediment and pollution within the Waimanalo and Inoa'ole Stream watersheds. Results would be used to develop cooperative agreements among basin landholders to improve stream conditions.
Land Management Units	Watercourse MEA	
Activities and Schedule	Prepare a Scope of Work in 2009; Complete project in 2011.	
Material and Labor Requirements	Labor: 1 fluvial geomorphologist, 50 hrs; 1 technician/clerical, 20 hours; 1 water quality specialist, 50 hours.	
Estimated Cost and Source of Funds	$24,000 ACES-PM, Conservation Resources Funding	

Required Outside Agency Consultation	None, but coordination with other basin landowners, such as MCTAB, is recommended.
Priority with this OCP	Level 2
Impact on Other Projects and on Overall Ecosystem Functions	Should be coordinated with sediment removal project. Low short-term impact to watercourse ecosystem, but helps to identify management actions for long-term improvements.
Appendix Material	None

10.4.2.3 Riparian Enhancement

An important component to protecting water resources is implementation of a riparian buffer zone, i.e., a strip of land from the bank of the stream inland that buffers the stream from a variety of activities. Reduction or elimination of activities in the riparian zone can reduce the level of negative impacts to a stream. Riparian vegetation provides stream bank stability, shade, cover, and nutrients to a stream and its aquatic fauna. Degradation of the riparian zone can lead to increased erosion, warmer stream temperatures, and other impacts. This INRMP recommends a minimum 35-foot riparian buffer strip along each watercourse bank (Bay Pacific Consulting 1996), except along small tributary ditches that are part of the Hickam AFB stormwater canal system. The Watercourse MEA uses this 35-foot buffer.

Vegetation maintenance should be minimized in the Watercourse MEAs except in areas where BASH is a concern. No turf mowing or tree pruning is allowed except as part of a riparian enhancement program.

Other than Hickam AFB and Bellows AFS, only Kipapa FSA has an identifiable watercourse. Due to the relatively small size of Kipapa FSA, watercourse protection for Kipapa Stream will occur by using BMPs during activities at the installation plus maintaining the 35-foot riparian buffer.

The Riparian Enhancement Project revegetates the riparian zone with trees and shrubs that can provide stream bank stability, shade, and cover for aquatic species and birds. Where practicable planted trees and shrubs should be native species and acquired through the Native Plant Horticulture Project.

This project is for Bellows AFS only (specifically, the north side of Waimanalo Stream that lies within the Bellows AFS property) . It does not include removal of the dike on Kipapa Stream. Removal of the dike to enhance this riparian zone requires further investigation to determine costs and benefits.

The cost estimate for this project assumes the following hourly rates: construction laborers, $36; engineer, $120; biologist, $96. The cost per tree is projected at $12, and $6 per shrub.

Project Name: Riparian Enhancement Project		
Affected Facilities	Bellows AFS	
Contribution to Management Goals and Objectives	Goal 2, Objective 3 Goal 4, Objective 1 Goal 4, Objective 3 Goal 5, Objective 3 Goal 10, Objective 1	The purpose of this project is to enhance the Bellows AFS side of Waimanalo Stream with suitable riparian vegetation.

Land Management Units	Watercourse MEA
Activities and Schedule	Develop Scope of Work by 2011; complete project by 2012.
Material and Labor Requirements	Material: Plants – up to 750 trees and 1,000 shrubs Labor: 3 construction laborers, 60 hours; 1 engineer, 30 hours; 1 biologist, 40 hours.
Estimated Cost and Source of Funds	$24,600 ACES-PM, Conservation Resources Funding
Required Outside Agency Consultation	USFWS and DLNR consultation recommended. A Section 404 permit may be required from the USACOE for clearing of existing riparian vegetation. Coordination with MCTAB is recommended.
Priority with this OCP	Level 3
Impact on Other Projects and on Overall Ecosystem Functions	Plants could be acquired from the Native Plant Horticulture Project. This project should benefit water quality for fish and wildlife, and improve riparian function.
Appendix Material	None

10.4.2.4 Watercourse Conveyance Enhancement

The Watercourse Conveyance Enhancement Project is designed for implementation at the canals at Hickam AFB and along Inoa'ole Stream at Bellows AFS. Mangroves in the canals on Hickam AFB reduce the canals' stormwater conveyance capacity and contribute to the risk of BASH; they have established a solid foothold around the base golf course and inside the reef runway jetty system. The Air Force should consider pursuing a partnership with Honolulu International Airport since removal of the mangroves from the canals would benefit the adjacent civilian airport as well.

At Bellows AFS, ironwood trees grow along the banks of Inoa'ole Stream. According to MCBH Marine Corps Training Area Bellows Watershed Impairment Study (Hood et al. 2002), many of the trees are old and falling into the stream, creating debris jams.

The best management practice (BMP) for removing mangroves from the canals is trimming (by hand or heavy machinery) the mangroves to below the high-tide line, or if on the banks, to ground level. Trimming, as long as the green waste is removed from the canals, does not require a Section 404 permit. However, should dredging be necessary, USACOE should be consulted to determine if a permit is required. Note that removal of mangroves from the canals should be conducted in accordance with the BMP and with oversight by the natural resources manager.

Detailed labor and material requirements for mangrove removal at Hickam AFB and ironwood removal at Bellows AFS are to be determined. They are dependent upon the availability of 15 AW personnel and the need for oversight by an archaeologist.

Project Name: Watercourse Conveyance Enhancement		
Affected Facilities	Hickam AFB, Bellows AFS	
Contribution to Management Goals and Objectives	Goal 4, Objective 3 Goal 5, Objective 7	The purpose of this project is to remove mangroves from Manuwai and Kumumau'u Canals at Hickam and aging ironwood trees along Inoa'ole Stream at Bellows AFS to increase stormwater conveyance capacity.
Land Management Units	Watercourse MEA Hickam AFB: Manuwai and Kumumau'u Canals Bellows AFS: Inoa'ole Stream	
Activities and Schedule	Project completion by 2009.	
Material and Labor Requirements	To be determined.	
Estimated Cost and Source of Funds	To be determined. Operations and Maintenance	
Required Outside Agency Consultation	A Section 404 permit may be required from the USACOE for clearing of existing vegetation.	
Priority with this OCP	O&M	
Impact on Other Projects and on Overall Ecosystem Functions	Hickam AFB project must be coordinated with the Sediment Removal Feasibility Study.	
Appendix Material	None	
Notes: There are two forms of mangrove removal: 1. Hand removal includes the use of chain saws to remove the tops above the prop roots. Mangroves eventually grow back, and the removal process is repeated. 2. Heavy equipment is used to remove the tops plus the root system. Any such removal in areas of high probability for archaeological resources needs to be coordinated with three Native Hawaiian Groups, because of the likelihood of disturbing subsurface deposits: the Office of Hawaiian Affairs, the Hui Malama I Na Kupuna' O Hawaii Nei, and the Oahu Island Burial Council.		

10.5 FISH AND WILDLIFE MANAGEMENT OPERATIONAL COMPONENT PLAN

Ecosystem management includes installation programs and activities to identify, maintain, and restore the composition, structure, and function of natural communities that comprise terrestrial and aquatic ecosystems to ensure their sustainability and biological diversity. Fish and wildlife management in Hawaii involves management of a variety of exotic and native species. The plan implementation measures and projects discussed in this operational component plan often overlap with those in previous sections in recognition of the interrelatedness of the natural ecosystems and human activities within these ecosystems. This chapter recognizes that exotic or imported species are well established on the installations. In specific cases, these non-native fish and wildlife need to be controlled in order to maintain or re-establish viable populations of native species.

10.5.1 Implementation Summary for Fish and Wildlife Management

Goal 5. Manage game and non-game fish and wildlife species within the DoD guidelines of ecosystem management.

Table 10.5-1 summarizes how each objective is to be implemented.

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TABLE 10.5-1 IMPLEMENTATION SUMMARY FOR FISH AND WILDLIFE MANAGEMENT

Objective 5.1 :	**Survey and monitor for the presence and abundance of selected game and non-game fish, aquatic invertebrates, and wildlife species and their habitats to observe and document improvement or degradation of conditions with time.**		
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Monitoring surveys for game and non-game species and their habitats shall be conducted at intervals of no longer than 5 years.	1. Implement the Monitoring Surveys Project and observe changes in habitat and population conditions.	10.2.2.5	All
	2. Use survey results to update GIS map layers.	10.11.2.4	All
	3. Update species presence lists using survey results.	Appendix C Appendix D	All
	4. Share survey results with applicable agencies.	Appendix I Appendix J	All
Objective 5.2 :	**Coordinate fish and wildlife surveys and methodologies with DLNR, USFWS, and NMFS by establishing points-of-contact and conducting textual, verbal, and face-to-face communications.**		
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Prior to the initiation of monitoring studies and species/habitat surveys, study plans will be coordinated with the three agencies. This can ensure that duplication of effort is avoided and that studies can enhance larger scale resource management efforts. There is potential for the scope and value of studies to increase along with decreases in individual agency costs through cost sharing.	1. Consult Appendix J for applicable statutes, responsible agency, and contacts for coordination. Revise the contact list annually.	Appendix I Appendix J	All
Include appropriate guidelines in study plans for actions that could affect listed species under Section 7 of the ESA.	1. Consult directly with USFWS and NOAA's NMFS to determine appropriate guidelines.	10.2 Appendix J	Hickam AFB Bellows AFS Kaala AFS Kokee AFS
Objective 5.3 :	**Develop appropriate strategies to maintain populations of game or non-game species, primarily through appropriate habitat management, but also through harvest management and enforcement of regulations, where practicable.**		
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**

Coordinate with state and federal game enforcement agencies.	1. Initiate discussions with game enforcement agencies to permit access to Air Force installations by enforcement agents on a regular basis.	Appendix I	Hickam AFB Bellows AFS
	2. Implement the Exotic Predator Control Project.	10.2.2.2	All
	3. Inform agencies of results of the Monitoring Surveys Project.	10.2.2.5	All
	4. Implement the Exotic Fish Eradication Project.	10.5.2.8	Hickam AFB
Improve riparian habitat conditions along Waimanalo Stream.	1. Implement the Riparian Enhancement Project.	10.4.2.3	Bellows AFS
Control pesticide, herbicide, and fertilizer use where these materials could gain access to surface waters.	1. Minimize use of these materials to control pests, and follow principles of integrated pest management and BMPs.	10.2 Appendix F Appendix P	All
	2. Identify levels of chemical contamination in Watershed Sediment Removal Feasibility Study Project.	10.4.2.1	Hickam AFB
	3. Identify on-base sources of pesticide, herbicide, and fertilizer pollution as part of the Watershed Assessments Project.	10.4.2.2	Bellows AFS
Objective 5.4 : Manage turf areas to maintain suitable habitat for golden plover.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Manage Landscaped – High Maintenance MEAs in order to provide appropriate habitat for golden plover.	1. Continue mowing frequencies currently in place for turf in Landscaped- High Maintenance MEAs.	9.2.7	All
Objective 5.5 : Develop educational programs to make base personnel and visitors aware of wildlife that use Air Force lands and what protection is needed to maintain wildlife populations.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Protect and maintain wildlife populations by developing interpretive kiosks, a Web Page, and other educational opportunities.	1. Implement Shoreline Access/ Interpretive Trails Project.	10.8.2.2	Hickam AFB Bellows AFS
	2. Implement Natural Resources Web Page Project.	10.2.2.4	All
	3. Implement Bird Watching Guide Project.	10.8.2.5	Hickam AFB Bellows AFS

Objective 5.6 : Develop and implement predator control and prey protection programs in areas where these animals pose a threat to threatened and endangered (Objective 2.4) or other species that are important to the health of the ecosystem. Incorporate protection from predators into habitat enhancement plans.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Determine the magnitude of exotic predator presence on installations. To the extent possible, maintain records of casual observations of predators by installation personnel or provide avenues for reporting observations.	1. Implement Exotic Predator Control Project, include recording of predator observations.	10.2.2.2	All
	2. Implement Exotic Fish Eradication Project, include recording of predator observations.	10.5.2.8	Hickam AFB
	3. Include exotic predator observation reporting opportunities in Natural Resources Web Page Project.	10.2.2.4	All
	4. Develop exotic predator observation reporting opportunities through email or other appropriate avenues.	None	All
Objective 5.7 : Manage wildlife habitat to minimize BASH: in runway areas, reduce habitat use by birds that could pose a threat to aircraft.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Review and implement Operation Plan 91-2 Bird Aircraft Strike Hazard Plan. Assign the natural resources manager to work with the Bird Hazard Working Group.	1. Follow BASH practices summarized in the Grounds Maintenance and Urban Forestry OCP and as described in the BASH Plan.	10.6 Appendix O	Hickam AFB
	2. Implement the Black-necked Stilt Radiotracking Project.	10.2.2.6	Hickam AFB
	3. Reduce BASH through removal of mangroves in canals at Hickam AFB.	10.4.2.4	Hickam AFB
	4. Natural resources manager shall attend the Bird Hazard Working Group quarterly meetings.	None	Hickam AFB
Objective 5.8: To the extent possible within the military mission on Air Force lands, minimize conflicts between base activities and protection of wildlife and wildlife habitat.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Minimize impacts of pesticide, herbicide, and fertilizer use.	1. Follow BMPs for pesticide, herbicide, and fertilizer use in the Watercourse MEA and in adjacent MEAs.	Appendix F	All
Implement this INRMP and update it at least every 5 years in accordance with Air Force Instruction 32-	1. The base comprehensive planner and natural resources manager shall meet at least quarterly to review proposed development plans and projects.	None	All

7064.	2. Inform military personnel, family members, and visitors of 15 AW Wildlife Management Safety Policy Letter.	Appendix O (BASH Plan Annex B, Section 7g)	Hickam AFB
Objective 5.9 : Ensure compliance with federal, state, and local laws and regulations regarding the management and preservation of wildlife.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Maintain an open dialogue with applicable agencies concerning regulated activities.	1. Consult list of agency contacts and update list regularly.	Appendix I	All
	2. Obtain all required permits, including sampling permits.	None	All
	3. Implement incidental take permit conditions.	10.2.2.1	Hickam AFB
	4. Implement Exotic Predator Control Project.	10.2.2.2	All
	5. Implement Exotic Fish Eradication Project.	10.5.2.8	Hickam AFB Bellows AFS
	6. Follow the requirements for a 40-foot setback from the high water mark along shorelines (Hawaii Coastal Zone Management Program, 1990). Seek required variances for any new development with the setback.	None	Hickam AFB Bellows AFS

10.5.2 Operational Component Plan Projects

The Operational Component Plan for Fish and Wildlife Management includes contributions from 10 projects. Of these, one project is an ACES-PM Level 1 priority (to begin during fiscal years 2008 and 2009), one project is Level 2 priority (to begin in 2009), six are Level 3 (to be accomplished by end of 2012), one is an unknown level, and one is an O&M funded project. The following projects help to implement Goal 5 objectives:

- Level 1
  -Monitoring Surveys
- Level 2
  -Watershed Assessment
- Level 3
  -Black-necked Stilt Radiotracking
  - Natural Resources Web Page
  -Exotic Predator Control
  -Shoreline Access/Interpretive Trails
  - Riparian Enhancement
  -Exotic Fish Eradication
- O&M

- Watercourse Conveyance Enhancement
- Unknown
-Watercourse Sediment Removal Feasibility Study

Four of the projects are designed to increase the available knowledge for management of fish and wildlife species on the installations covered in this Plan: Watercourse Sediment Removal Feasibility Study, Monitoring Surveys, Black-necked Stilt Radiotracking, and Watershed Assessment. These four are described in Section 10.5.2.

To protect overall ecosystem health, pesticide, herbicide, and fertilizer use in MEAs adjacent to the Watercourse MEA (particularly the Landscaped-High Maintenance MEA) should be minimized and alternate methods considered prior to their use. Overuse, or misuse, of these products can have negative impacts on fish, wildlife, and marine resources if they become present in surface waters. Consequently, all grounds maintenance supervisors will be responsible for knowing proper handling and application procedures for these chemicals and will be responsible for training maintenance crews in their proper use. Best Management Practices for their use are presented in Appendix F, while the *Pest Management Plan, Hickam Air Force Base and Bellows Air Force Station* is provided in Appendix P. See also Section 10.6, Grounds Maintenance and Urban Forestry, for specific projects concerning chemical management.

10.5.2.1 Watercourse Sediment Removal Feasibility Study

A feasibility study for the removal of sediments within the canals and streams of Hickam AFB is currently recommended. Likely benefits include better water quality and greater stormwater conveyance. See Section 10.4.2.1 for the project description.

10.5.2.2 Monitoring Surveys

Field surveys are required for monitoring the condition of populations and their habitats. The results will help indicate whether other projects are successful or need modification. Surveys will be implemented following consultation with the appropriate state and federal agencies. Cost- and labor-sharing strategies with these agencies will be pursued. See Section 10.2.2.5 for the project description. The described surveys will apply to a range of species in addition to any applicable T&E species.

10.5.2.3 Black-necked Stilt Radiotracking

The black-necked stilt *(Himantopus mexicanus knudensi)* is an endangered species protected by federal law. Although currently not a significant problem, this wading bird could be a significant contributor to BASH if its use of Hickam AFB increased. Any attempts to improve nesting or foraging habitat (wetlands, shoreline, or watercourse) for black-necked stilt at Hickam AFB would need full consideration of the risk to increased BASH.

The risk of BASH is a serious concern that currently limits the available options for habitat enhancement at Hickam AFB. The radiotracking project is designed to increase the available information about black-necked stilt flight behavior patterns and habitat use. The results could be used to identify areas where habitat enhancement projects could be attempted without an undue risk of

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increased BASH. If possible this project should be implemented with cost- and labor-sharing between the Air Force, the U.S. Fish and Wildlife Service, and the University of Hawaii. See Section 10.2.2.6 for the project description.

10.5.2.4 Watershed Assessment

Watershed assessment is an integrated approach to examine anthropogenic impacts on whole basins and has become an important tool for natural resource management. The assessment usually includes examination of stream hydrology, water quality and beneficial uses, fish habitat, soils and topography, channel morphology, land use, and riparian function, but may also include wildlife habitat. A focused watershed assessment is included in this INRMP for the Waimanalo and Inoa'ole Streams' watersheds in order to determine the on-base sources and sinks of sediment and pollution. The results of the study will be useful to the Air Force in developing cooperative agreements among landowners, DOH, and the Air Force and in targeting effective remediation projects within the watershed. See Section 10.4.2.2 for the project description.

10.5.2.5 Watercourse Conveyance Enhancement

Management of vegetation in areas adjacent to the Hickam AFB airfield to reduce bird habitat and risk of BASH are also incorporated in this plan. Mangroves within the storm drainage canals have been identified as attractive to birds implicated in BASH. Although this activity negatively impacts the availability of bird habitat, it is a necessary activity to safely meet the base mission. Specific locations for removal are to be coordinated with Operations Support and the USDA APHIS-ADC. See Section 10.4.2.4 for the project description.

10.5.2.6 Shoreline Access/Interpretive Trails

The Shoreline Access/Interpretive Trails Project is presented in Section 10.8.2.2, in the Operational Component Plan for Outdoor Recreation and Public Access. It is also an educational project for fish and wildlife. It is designed to inform on-base personnel and visitors about natural resources present at the installations and to contribute to an educational experience, including watching wildlife. Education is one of the most important means to help preserve natural resources through heightened awareness and appreciation of the urban and natural ecosystems in which we live.

The objective of this project is to provide low-impact walking trails with educational signs describing marine, coral reef, and wetland ecosystem function. The affected installation is Hickam AFB. If any of the wetlands require some filling during trail construction, a Section 404 permit from the U.S. Army Corps of Engineers is required (unless determined to be exempt due to small size of filled area).

10.5.2.7 Natural Resources Web Page

The Natural Resources Web Page is proposed as an educational project designed to inform on-base personnel and visitors about natural resources present at the installations and how they can access them. The project can be coordinated with other projects such as the Shoreline Access/Interpretive Trails Project (10.8.2.2), to direct base residents and visitors to related educational opportunities. See Section 10.2.2.4 for the project description.

10.5.2.8 Exotic Fish Eradication

The spread of exotic species is known to be detrimental to the long-term survival of many native Hawaiian plants and animals. This plan proposes two projects for the removal of exotics. The Exotic Fish Eradication Project is designed to eliminate species such as tilapia and mosquitofish from streams and canals on Hickam AFB. Removal methods should be considered carefully and discussed with state and federal. agencies prior to implementation, due to the risk of harm to desirable species such as native gobies. Furthermore, if the risk of reinvasion is high, then little long-term benefits would result from implementing this project. The second removal project is Exotic Predator Control, discussed in the following section.

The cost estimate for this project is based on hourly rates of $96 for a mid- to senior level fisheries biologist and $60 for a junior level biologist. A team of three would cost roughly $252 per hour and would work for approximately 200 hours.

Project Name: Exotic Fish Eradication		
Affected Facilities	Hickam AFB	
Contributed to Management Goals and Objectives	Goal 1, Objective 1 Goal 5, Objective 3 Goal 5, Objective 6 Goal 5, Objective 9	The purpose of this project is to eliminate exotic fish species from the streams and canals on Hickam AFB.
Land Management Units	Watercourse Hickam AFB	
Activities and Schedule	Begin consultation with the USFWS and Hawaii DLNR and complete project scoping during 2010. Project completion in 2011.	
Material and Labor Requirements	Material : electrofisher, nets, or chemicals. Labor : 3 fisheries biologists, 600 hours total.	
Estimated Cost and Source of Funds	$72,000 ACES-PM, Conservation Resources Funding	
Required Outside Agency Consultation	Hawaii DLNR, USFWS. A scientific fishing permit will be required.	
Priority with this OCP	Level 3	
Impact on Other Projects and on Overall Ecosystem Functions	This project should be coordinated with the sediment removal and watercourse conveyance enhancement projects. It would have a benefit on the overall aquatic ecosystem.	
Appendix Material	Appendix D (Native and non-native fish species list)	

10.5.2.9 Exotic Predator Control

Exotic predators can severely impact wildlife species, particularly birds. Predators are a problem throughout Oahu and Kauai. Installations with identified exotic predator problems, which primarily include Hickam AFB, Bellows AFS, Kaala AFS, and Kokee AFS, will implement a trapping and removal program in coordination with DLNR. The Exotic Predator Control Project is initially proposed for all installations, but should be discontinued or modified at installations proving to have a low rate of captures. Hickam AFB will continue to cooperate with the Hawaii Department of Agriculture (DOA) and USFWS to prevent the accidental establishment of the brown tree snake, which has devastated endemic species in Guam. For a project description, see Section 10.2.2.2.

10.5.2.10 Riparian Enhancement

The Riparian Enhancement Project revegetates the riparian zone of Waimanalo Stream (that falls within Bellows AFS boundaries) with trees and shrubs that can provide streambank stability, shade, cover, and nutrients to the stream for aquatic species and birds.. For the project description, see Section 10.4.2.3.

10.6 GROUNDS MAINTENANCE AND URBAN FORESTRY OPERATIONAL COMPONENT PLAN

Grounds maintenance and urban forest management practices help to maintain and improve the aesthetic appearance of the lands managed by 15 AW and can contribute to overall biodiversity and ecosystem health. The purpose of this operational component plan is to identify implementation projects that encourage ecologically responsible, cost-efficient management of urban landscaped lands, while protecting and maintaining the visual quality of those resources. This grounds maintenance and urban forestry section of the INRMP addresses primarily the lands which are landscaped, including public walkways, roadsides, building vicinities, and organized outdoor recreation areas, such as ball fields. It also addresses vegetation management at the installation perimeter or fenceline. In some cases, vegetation outside the installation is managed for fire hazard control.

Air Force Policy

Air Force policies and guidelines regarding grounds maintenance and urban forest management are included in Chapter 11 of AFI 32-7064, under Land Management. This document encourages using native plants in landscape designs, minimizing landscape maintenance, minimizing the need for irrigation, and naturalizing landscaped areas as much as possible. The Instruction requires that an urban forestry plan be completed, and that a Tree City USA designation be obtained for urban forestry programs in Hawaii. The use of integrated pest management practices is encouraged in both AFI 32-7064 and AFI 32-1053. These policies are either currently implemented on lands managed by Hickam AFB or are planned for implementation in this section, as noted in the objectives listed above.

Grounds Categories

The lands managed by 15 CES at Hickam AFB are divided into improved, semi-improved, and unimproved, based on the frequency and intensity at which grounds management practices are performed. Some of the improved grounds are further classified as high visibility. High visibility areas are generally defined by the current Wing Commander, but typically include main gates, thoroughfares, headquarters buildings, and other prominent areas. The following table shows the varying levels of maintenance scheduled for each grounds category.

TABLE 10.6-1 TYPICAL FREQUENCY OF TURF MAINTENANCE ON LANDS MANAGED BY 15 CES, HICKAM AFB

Turf Classification	Mowing Frequency	Watering Frequency

High Visibility	Twice a week	Three times a week
Improved	Once a week	Twice a week
Semi-Improved	Every two weeks	Twice a week
Unimproved	none	none
Note: Mowing and watering frequency may vary depending on recent weather conditions.		

Maintenance Responsibility

Regular maintenance of most of the improved and semi-improved lands managed by 15 CES is performed by a contractor, with oversight from contract supervisors in the Operations Flight. At Hickam AFB, mowing of the airfields, installation of new landscaping, emergency tree trimming, pest control, and other small landscaping jobs are performed by employees of the Grounds Shop. Limited grounds maintenance tasks are also performed by Air Force employees stationed at Bellows AFS, Kaala AFS, and Kokee AFS, although the bulk of the labor is contracted out. The golf courses at Hickam AFB are maintained by golf course employees, residential lawns are maintained by housing residents, and the ball fields are maintained by a private contractor with oversight from The Air Force Services Agency (HQ AFSVA). The landscape designer in the Engineering Flight at Hickam AFB proposes and designs most of the landscaping projects for Hickam AFB and Bellows AFS.

Pest and Weed Control

The base landscape designer is typically alerted of pest sightings and generally decides how infestations are handled (Iwamoto 1996a). The most common pest problems are beetles and blister mites, which are usually controlled by cutting the plants back (Iwamoto 1996a). The most common weeds are nut grass and sleeping grass, which are typically mowed or pulled out by hand (Iwamoto 1996a, Chapin 1996).

A concerted effort is made to minimize the use of pesticides and herbicides. When chemical spraying is needed, it is usually done by the Grounds Shop crew. The base follows EPA and state laws on chemical use, and clearance is obtained from the Environmental Section before spraying (Iwamoto 1996a). Also, Hickam AFB and Bellows AFS have a Pest Management Plan (see Appendix P) which is based on the principles of integrated pest management. These are appropriate pest and weed control practices that should be continued.

The following principles of integrated pest management should be fully implemented on lands managed by 15 CES:

- Reduce the amount of chemicals applied within the watershed to the minimum amount necessary to control the pest problem.
- Consider and use when appropriate nonchemical control methods, such as manual vegetation removal or biological pest control that does not require importation of non-native species.
- Avoid making applications prior to any rainfall or in winds greater than 10 mph.

- Investigate using less toxic pesticides which biodegrade in a shorter period of time.
- Reduce the amount of pesticides and herbicides that are applied near bodies of water by using them only on an as-needed basis (contamination of ponds or watercourses can occur by overspraying, direct runoff into the water, or subsequent flushing into the water by stormwater runoff).

BASH Practices

The grass height in the vicinity of the runways and taxiways at Hickam AFB should be maintained at 3-4 inches to discourage birds from landing (Ohashi 1996). The variety of grass, known as bufflegrass, that was seeded in the airfield area is appropriate to BASH reduction efforts (Ohashi 1996). Areas in the airfield that rapidly develop shrub cover that might attract birds, such as the approach area to runway 8L, should be mowed regularly to prevent kiawe and koa haole from establishing (Ohashi 1996). The general rule for trees near airfields is that no obstructions are allowed within the transitional surface of the runways. This is an imaginary plane extending upwards on a 7:1 slope from the runway to an imaginary line on the ground 750 feet from the runway centerline. Trees and shrubs that meet these height restrictions, but are bird attractants, may also be removed. Further details on current BASH practices may be found in the BASH Plan (15 AW 2005) provided in Appendix O.

Irrigation

Since the Island of Oahu is limited in the availability of fresh water, water is generally expensive and considered valuable. The extensive landscaped areas at Hickam AFB and Bellows AFS require large amounts of water to maintain green, healthy vegetation. Intensive irrigation is needed because much of Hickam AFB has only 2-3 inches of topsoil, and water is not held in the surface soils for long periods of time (Iwamoto 1996a). Most grassy areas on Hickam AFB will begin to turn brown, and shrubs and trees will begin to show distress, after 1 week with no water or rainfall (Iwamoto 1996a). This decline in the appearance of the landscape has not been acceptable to Wing Commanders in the past; however, rising water costs will inevitably bring more pressure to bear on the base to reduce overall water usage (Iwamoto 1996b).

Irrigation needs should be reduced by increasing the use of native plant species or exotic species that are adapted to the conditions of the area. All new landscaping plans are currently designed to include built-in irrigation systems (Iwamoto 1996b). Master controller switches should be installed so the sprinkler heads in specific areas can be controlled separately from the basewide timer system. This will enable landscapers to switch off some or all of the sprinklers to preserve water when rainfall or cloudy weather precludes the need for watering. Another option is to use moisture sensing technology or "thermistor" to control irrigation water. Grasses outside of high-visibility areas should be allowed to grow to 4 inches, rather than the typical 2.5 or 3 inches, as longer grass slows the process of evapotranspiration (the combined loss of water as water vapor from the soil surface and from the leaf surface), thus helping to retain soil moisture.

Management Challenges

Grounds maintenance practices at Hickam AFB reflect the position of the base as PACAF headquarters and the central showpiece of Air Force installations in the Pacific. There is a strong emphasis on highly manicured lawns, the use of showy flowering plants which are typically non-native, and formal plantings of palms and other subtropical trees. Many of these plantings have historical significance. These practices result in beautiful landscaping that is relatively high maintenance, requiring considerable labor, as well as significant quantities of fertilizers and water. Past Commanding Officers at Hickam AFB have consistently requested that landscapers maintain this high level of grooming as part of the aesthetic identity of the base. This directive has limited the options for landscape planners who are also tasked with reducing irrigation requirements and chemical use, and must face reduced labor budgets.

The primary challenges that are faced by grounds managers at Hickam AFB include:

1. the lack of a landscape development master plan
2. changes in landscape priorities with new Wing Commanders
3. limited water availability
4. limited training for landscape installers
5. the prevalence of shallow, nutrient-poor soils with brackish ground water at Hickam AFB
6. the visibility of Hickam AFB as PACAF headquarters and a significant WWII era battle site
7. the high cost of maintenance of extensive landscaping.

This operational component plan is intended to address these problems and to aid in developing a comprehensive, integrated landscape management approach.

10.6.1 Implementation Summary for Grounds Maintenance and Urban Forestry

Goal 6: ***Manage grounds and urban trees to optimize protection of existing ecosystems, and maintain visually attractive landscapes on Air Force installations visited by the public.***

Table 10.6-2 summarizes how each objective is to be implemented.

TABLE 10.6-2 IMPLEMENTATION SUMMARY FOR GROUNDS MAINTENANCE AND URBAN FORESTRY

Objective 6.1 : Identify grounds maintenance needs on each installation.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Implement the OCP for Grounds Maintenance and Urban Forestry and update at least every 5 years.	1. Implement the Woody Fuel Survey and Removal Project.	10.6.2.3	Bellows AFS
	2. Implement Reorganization and Training Program for Grounds Shop Employees.	10.6.2.4	Hickam AFB
	3. Implement Landscape Development Master Plan Project.	10.6.2.6	All
	4. Implement Revegetation of Ammunition Storage and Training Areas Project.	10.6.2.8	Hickam AFB
Objective 6.2 Develop a tree management plan based on an inventory of urban trees at Hickam AFB.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Inventory and manage urban trees at Hickam AFB	1. Implement Urban Tree Inventory Project.	10.6.2.2	Hickam AFB
	2. Implement Urban Forestry Management Plan Project.	10.6.2.9	Hickam AFB
	3. Implement Landscape Development Master Plan Project.	10.6.2.6	All
Objective 6.3 Apply for Tree City USA designation at Hickam AFB.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Meet standards for becoming a Tree City USA.	1. Implement Tree City USA Designation Project.	10.6.2.7	Hickam AFB
Objective 6.4 Through the use of landscape design appropriate to site-specific conditions and aesthetic requirements, minimize the amount of irrigation and labor needed for maintaining ground on Air Force lands.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Coordinate landscape plans with irrigation and labor needs using information gathered from grounds maintenance and landscaping groups	1. Implement Reorganization and Training Program for Grounds Shop Employees.	10.6.2.4	Hickam AFB
	2. Implement Landscape Development Master Plan Project.	10.6.2.6	All
Objective 6.5 Utilize an integrated pest management program to control bird, mammal, reptile, and insect pests and noxious weeds.			
Implementation Process	**Project/Action**	**Report**	**Applicable**

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		Section	Installations
Develop pest management program for landscaping	1. Implement Landscape Development Master Plan	10.6.2.6	All
Include pest management as part of urban forestry management at Hickam AFB.	2. Implement Urban Forestry Management Plan Project.	10.6.2.9	Hickam AFB
Objective 6.6: Manage recreational use of Air Force lands to avoid damage to landscaped areas.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Provide nature study opportunities which highlight significance of plant species at Hickam AFB.	1. Implement Self-Guided Horticultual Tour Project	10.6.2.5	Hickam AFB
Develop recreational trails which protect landscaped areas.	2. Implement Shoreline Access/Interpretive Trails Project	10.8.2.2	Hickam AFB Bellows AFS
Objective 6.7: On Air Force installations in close proximity to native vegetation, utilize native species in landscaping and do not introduce exotic species. Reduce undesirable vegetation, and maintain biological diversity.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Develop native species and reduce use of non-native species in landscaping by controlling invasive exotic plant species and creating a nursery of native plants, which may be operated by private citizens.	1. Implement Control of Invasive Plant Species Project.	10.6.2.1	Kaala AFS Kokee AFS
	2. Implement Outleasing for Native Plant Horticulture Project.	10.9.2.1	HickamAFB Kipapa FSA Waikakalaua FSA
Objective 6.8: Control vegetation at the installation perimeter to reduce wildfire hazard.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Remove vegetation at installation perimeters where necessary, using established removal practices.	1. Continue current vegetation control practices using mowers and/or brush cutting machinery	None	Bellows AFS Waikakalaua FSA Kaala AFS Kokee AFS
	2. Implement the Woody Fuel and Flammable Vegetation Survey and Removal Project	10.6.2.3	Bellows AFS

10.6.2 Operational Component Plan Projects

This plan proposes ten projects which are designed to maintain the landscaped areas, improve management of these areas, and enhance the enjoyment of outdoor landscaped areas. Of these, two are Level 2 priority and six are Level 3 projects. Two projects are O&M projects, including the revegetation project at Hickam AFB which is either O&M or ACES-PM Level 3 and is listed twice. The following projects help to implement Goal 6 objectives and are described below:

- Level 2
  -Control of Invasive Plant Species
  -Urban Forestry Management Plan

- Level 3
  -Urban Tree Inventory
  -Woody Fuel and Flammable Vegetation Survey and Removal
  -Reorganization and Training Program for Grounds Shop Employees
  -Self-guided Horticultural Interpretive Tour
  - Tree City USA Designation
  - Revegetation of Ammunition Storage and Training Areas

- O&M
  -Landscape Development Master Plan
  -Revegetation of Ammunition Storage and Training Areas

10.6.2.1 Control of Invasive Plant Species

Invasive plant species on installation lands threaten the integrity of native plant communities and potential habitat for T&E plant species at Kaala AFS and Kokee AFS. The following table indicates the problem species and locations, based on surveys conducted by Hickam AFB natural resources personnel in 2006:

TABLE 10.6-3 INVASIVE PLANT SPECIES ADJACENT TO NATIVE PLANT COMMUNITIES, 15 AW INSTALLATIONS, HAWAII

Facility	Location	Plant Species	Threatened Community
Kaala AFS	Blackberry occurs just outside of the south and east fenceline, extending just onto Kaala AFS, and up to 300 feet outside the site boundaries; ginger is in one location along south fenceline.	Florida blackberry (Rubus argutus) Firespike (Odontonema cuspidatum) Buddleia asiatica Maui pamakani (Ageratina adenophora) Impatiens (Impatiens sp.) Yellow ginger (`awapuhi melemele, Hedychium Flavescens	`ohi`a wet forest
Kokee AFS	Kahili ginger is in an isolated patch outside the eastern fence line but might be growing in clumps within the forested area. Three faya trees are within the installation, with several more outside the north and northwest fence line. Fleabane daisy occurs in spreading clumps ouside north fence line. Blackberry	Kahili ginger (Hedychium gardnerianum) Faya tree (Morella faya) Fleabane daisy (Erigeron karvinskianus) Blackberry (Rubus argutus) Banana poka (Passiflora mollissima)	Diverse mesic forest

	is also scattered along the fence line. One banana poka vine is climbing through native forest outside the eastern fence line.		

Ginger is considered a noxious weed in Hawaii when it occurs in wet areas with sensitive native plant communities. The ginger plants at Kaala AFS and Kokee AFS are producing fruit with seeds, which spread easily. These plants also spread by rhizomes, which form thick mats, crowding out adjoining native species (Char 1996). Blackberry spreads easily by both rhizomes and seeds, climbing over and smothering native plants. Firespike has recently been documented to naturalize (i.e., reproduce and disperse through seeds, not merely spread vegetatively) on Maui, Kauai, and the Big Island. *Buddleia* and Maui pamakani are widespread weeds, and the latter is classified as a federal noxious weed. Impatiens is considered an invasive species in Hawaii.

Ginger and blackberry are best removed by spot spraying with a biodegradable herbicide such as Roundup, but Natural Area Reserve botanists of the DLNR should be consulted on methods prior to control attempts. Repetitive applications of herbicide on blackberries will be necessary; control rather than eradication is most likely. Fleabane should be sprayed with herbicide and monitored on a regular basis to ensure that it does not continue to spread. Native plants should naturally move into these areas once competition from exotic species is removed. Invasive weed control should be coordinated with Army Natural Resources staff for Kaala AFS and with the Resource Conservation Program for Kokee AFS, who currently maintain active weed control programs on properties adjacent to the installations.

The cost estimate for this project is based on an hourly rate of $36 for landscapers.

Project Name: Control of Invasive Plant Species		
Affected Facilities	Kaala AFS, Kokee AFS	
Contribution to Management Goals and Objectives	Goal 2, Objective 3 Goal 2, Objective 5 Goal 6, Objective 7	The purpose of this project is to remove invasive exotic plant species from areas adjacent to native plant assemblages.
Land Management Units	Manage Natural Habitat	
Activities and Schedule	Complete initial project in 2009.	
Material and Labor Requirements	Materials: herbicide, gardening tools. Labor: 2 landscapers, 300 hours each for start-up, 150 hours each annually.	
Estimated Cost and Source of Funds	$28,800 start-up, $12,000 annually Operations and Maintenance; costs may be reduced through the use of volunteer labor; however, only licensed applicators can apply herbicides.	
Required Outside Agency Consultation	None required. Consultation with DLNR is recommended.	
Priority with this OCP	Level 2	

Impact on Other Projects and on Overall Ecosystem Functions	This project will enhance native plant communities and potential habitat for T&E species.

10.6.2.2 Urban Tree Inventory

This plan for an urban tree inventory is consistent with guidelines in the *Department of Defense Urban Forestry Manual* (DENIX 1996). Baseline information for the tree inventory will come from the tree cover map generated for this INRMP (Figure 6-2) and the General Landscape Development Plan (GLDP) maps, which are outdated but correctly identify the location and species of many of the trees in landscaped areas on Hickam AFB. A comprehensive tree inventory will then be conducted to confirm the species, location, diameter at breast height (4.5 feet above-ground level on high side), condition, maintenance requirements, location of adjacent utilities, such as overhead power lines or underground lines, and damage to adjacent landscape (sidewalks, roads, etc.) which has been caused by a particular specimen. The locations of trees will be digitized from the GLDP maps using a GeoBase. Tree locations will be confirmed in the field using hand-held Global Positioning System (GPS) units.

With 50,000-60,000 trees at Hickam AFB, such an inventory will be a major work effort. Each individual performing the inventory may collect data from 150 to 700 trees per day, depending on experience of the individual, stand uniformity, species variation, etc. Prioritizing areas for inventory will allow for phasing of the project.

Phase 1: High-priority areas that will be inventoried in the first phase include high-visibility and historically significant areas. These include the main gate area, Eighth and Ninth Streets with the *Ficus benjamina* and date palms, Boquet Boulevard, Signer Boulevard, Mills Boulevard, Fox Boulevard, Fort Kamehameha Historic District site, the proposed Historic District area, and other areas. Historic areas are designated on the tree cover map (Figure 6-2).

Phase 2: These areas will include all remaining areas around public buildings.

Phase 3: This phase will cover residential, recreational, and all other remaining areas.

Project Name: Urban Tree Inventory		
Affected Facilities	Hickam AFB	
Contribution to Management Goals and Objectives	Goal 6, Objective 2	This project will assist in identifying grounds and maintenance needs on each installation and is needed for Tree City USA designation.
Land Management Units	Landscaped – High Maintenance Landscaped – Low Maintenance	
Activities and Schedule	Complete Phase 1 inventory by 2009 in historic areas and high-visibility areas. Complete Phase 2 in remaining areas in 2010.	
Material and Labor Requirements	Materials: tree inventory software, laptop computer, GPS unit. Labor: urban forester/landscape architect for project oversight, 320 hours; landscapers or horticulturalists, 1,500 hours. This Urban Tree Inventory would be integrated with the SDS Geodatabase (in NAD83 meters projection) System using ArcMap 9.1.	
Estimated Cost and Source of Funds	Inventory software and GPS $42,000 High-visibility streets (app. 650 trees) $3,000 Fort Kamehameha Historic District $25,320 Proposed Historic District $126,700 Remaining Areas $98,400 Total $295,420 ACES-PM, Conservation Resources Funding. Project costs have been reduced by 20 percent through the use of volunteer labor, although training and oversight would be necessary.	
Required Outside Agency Consultation	None	
Priority with this OCP	Level 3	
Impact on Other Projects and on Overall Ecosystem Functions	Inventory information will be essential in the development of an urban forestry management plan.	
Appendix Material	None	

10.6.2.3 Woody Fuel and Flammable Vegetation Survey and Removal

Residential property owners adjacent to Bellows AFS have expressed concerns over the presence of woody debris and flammable vegetation in areas adjacent to their property which may increase the risk of fire and property damage. This project addresses this concern by surveying the fuel load level on Bellows AFS and removing excess levels along the perimeter which may increase fire risk to neighboring properties. The survey will also make recommendations for woody fuel

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and wildfire management throughout the base. (Note that MCBH has funded a series of studies to look at vegetation type/coverage at MCTAB (GII 2004) and associated vegetation management strategies (SWCA 2006), which provides an opportunity for collaboration with MCBH. Also, MCBH G-3 Training Management Office has recently funded a Wildland Fire Management Plan for MCBH properties, including MCTAB, thus providing another opportunity for coordinating efforts on flammable vegetation removal.)

The cost estimate for this project is based on hourly labor rates of $108 for a forestry specialist and $36 for grounds maintenance crews.

Project Name: Woody Fuel and Flammable Vegetation Survey and Removal		
Affected Facilities	Bellows AFS	
Contribution to Management Goals and Objectives	Goal 6, Objective Goal 6, Objective 8	The purpose of this project is to survey the fuel load level on Bellows AFS, remove excess amounts that increase fire risk to neighboring properties, and make recommendations for woody fuel flammable vegetation management on the base.
Land Management Units	Intensive Training	
Activities and Schedule	Complete project in 2011.	
Material and Labor Requirements	Labor: fuel load and forestry specialist, 80 hrs; 2 person grounds maintenance crew, 320 hrs.	
Estimated Cost and Source of Funds	$36,000 ACES-PM, Conservation Resources Funding	
Required Outside Agency Consultation	None	
Priority with this OCP	Level 3	
Impact on Other Projects and on Overall Ecosystem Functions	Reduction of wildfire risk reduces the potential for negative impacts to wildlife, aquatic, coastal, and water resources.	
Appendix Material	None	

10.6.2.4 Reorganization and Training Program for Grounds Shop Employees

The Grounds Shop is considered part of the Heavy Repair Element at Hickam AFB and is typically staffed with employees who are trained to operate mowing machines, trucks, and other large equipment. These employees, and their immediate supervisors, generally do not have planting or other landscaping experience. The emphasis in the Grounds Shop has been on the operation of machines rather than on caring for plants. For this reason, projects such as native plant nurseries have not succeeded in the past (Iwamoto 1996b). Grounds Shop employees should be made directly responsible to the Base Landscape Designer, who designs the planting projects and oversees their continued progress. Standard methods for tree and shrub trimming, planting, fertilizing, and watering should be established by the Base Landscape Designer, and passed directly on to Grounds Shop employees.

The cost estimate for this project is based on a projected annual salary of $60,000 for a landscape designer.

Project Name: Reorganization and Training Program for Grounds Shop Employees		
Affected Facilities	Hickam AFB	
Contribution to Management Goals and Objectives	Goal 6, Objective 1 Goal 6, Objective 4	The purpose of this project is to make Grounds Shop employees responsible to the Base Landscape Designer and provide them adequate training on plant installation and maintenance with major emphasis on tree trimming practices.
Land Management Units	Landscaped – High Maintenance Landscaped – Low Maintenance Bird-Aircraft Strike Hazard Reduction Intensive Recreation	
Activities and Schedule	Establish an in-house training program for all Grounds Shop employees by 2012.	
Material and Labor Requirements	Landscape designer/horticulturalist, 160 hours start-up, 120 hours annually	
Estimated Cost and Source of Funds	$12,000 start-up, $9,000 annually Operations and Maintenance Fund	
Required Outside Agency Consultation	None	
Priority with this OCP	O&M	
Impact on Other Projects and on Overall Ecosystem Functions	Positive impacts on landscape projects and greater success with native plantings than in the past.	

10.6.2.5 Self-Guided Horticultural Interpretive Tour

This project consists of designing and providing a pamphlet and numbered wooden signs by which base residents and visitors could guide themselves on a walking tour of the horticultural highlights of Hickam AFB. A botanist or horticulturalist will write the text for the pamphlet, identifying such features as

historical tree plantings, rare tree species, identification of common urban trees and flowering landscape plants, types of urban forest bird habitat, native Hawaiian uses for specific plants, methods of plant introduction to Hawaii, interesting insect and bird pollinators of specific plants, and other features. The pamphlet could be disseminated to new arrivals to the base, and/or available upon request at MWR, Public Affairs, and/or Natural Resources offices. The existence of the pamphlet will be publicized in the base newspaper, the *Kukini*.

An option (not costed) would be to develop an interactive electronic version of the interpretive tour and make it accessible through the Hickam AFB Web Page. Material from the pamphlet plus photographs, video, and audio could be used to create a multimedia experience.

The cost estimate for this project is based on projected hourly labor rates of $96 for a botanist, $84 for a photographer, and $84 for a graphic designer.

Project Name: Self-Guided Horticultural Interpretive Tour		
Affected Facilities	Hickam AFB	
Contribution to Management Goals and Objectives	Goal 1, Objective 1 Goal 6, Objective 6, Goal 8, Objective 2	The purpose of this project is to provide a nature study opportunity of the historically and horticulturally significant plant species on Hickam AFB.
Land Management Units	Landscaped – High Maintenance Landscaped – Low Maintenance	
Activities and Schedule	Develop pamphlet and post numbered signs by 2012.	
Material and Labor Requirements	Materials: photographic and printing costs of $6,960. Labor: botanist/horticulturalist, 200 hours; photographer, 40 hours; graphic designer/nature illustrator, 120 hours.	
Estimated Cost and Source of Funds	$39,600 (not including Web Page) ACES-PM, Conservation Resources Funding The cost of this project could be reduced through the use of volunteer labor by amateur horticulturalists, historians, and/or garden club members.	
Required Outside Agency Consultation	None, although informal consultations with DLNR likely.	
Priority with this OCP	Level 3	
Impact on Other Projects and on Overall Ecosystem Functions	Enhance public awareness of plant requirements and sensitive areas. As native trees and other plants are established, educate base visitors about native plants.	
Appendix Material	None	

10.6.2.6 Landscape Development Master Plan

Many of the problems associated with grounds maintenance and landscaping on Air Force lands could be addressed by developing a master plan that establishes a consistent approach and clear objectives. The plan will emphasize Air Force policies on maximizing the use of native plant species, minimizing maintenance requirements, reducing irrigation needs, using integrated pest management practices, reducing ephemeral ponding problem, and converting improved grounds to semi-improved, or semi-improved to unimproved wherever

appropriate (USAF 1994, 2002). The bulk of the plan will consist of a prioritized list of landscape projects and detailed project descriptions, intended for implementation over a 5-year period at Hickam AFB and the satellite installations.

The following maintenance reduction practices are currently used at Hickam AFB and will be emphasized in the new master plan:

- include an irrigation system with built-in sprinkler heads for all new landscape projects, and consider thermostat-controlled irrigation (soil moisture sensing)
- focus the most intensive maintenance on high-visibility areas, allowing less visible areas to receive less frequent maintenance
- select low-maintenance plants that are adapted to the conditions of the base (appropriate native and exotic plants will be identified for each installation in the plan)
- use native species as much as possible in designing new plantings
- strive for a natural look by randomly spacing plantings and by trimming hedges and shrubs to better mimic the natural shapes of the plants, avoiding boxy cutting and overtrimming
- simplify landscape designs by using fewer, more hardy species, and by grouping plants with similar maintenance requirements and growth needs

Having a 5-year plan that prioritizes projects and clarifies management policies should stabilize landscaping priorities and grounds maintenance practices, so they do not change with every change of base command. Landscape designers will be supported by the plan in their efforts to design plantings that require less water and reduced amounts of chemicals (e.g., pesticides, herbicides, fertilizers), that use more native plant species, and that are most appropriate to the soil and microclimate of the installation.

An urban tree management plan for Hickam AFB is presented in Section 10.6.2.9 and is separate from this project for a landscape development master plan.

The cost estimate for this project is based on a projected labor rate for a landscape architect of $120/hr.

Project Name: Landscape Development Master Plan		
Affected Facilities	All	
Contribution to Management Goals and Objectives	Goal 2, Objective 6 Goal 6, Objective 1 Goal 6, Objective 2 Goal 6, Objective 4 Goal 6, Objective 5	The purpose of this project is to develop a master plan that establishes consistent landscaping objectives and policies, and lists and prioritizes proposed landscape projects over a 5-year period.
Land Management Units		Landscaped – High Maintenance Landscaped – Low Maintenance

Activities and Schedule	Develop draft of plan in 2010; begin implementing plan upon approval.
Material and Labor Requirements	Landscape architect, 300 hours.
Estimated Cost and Source of Funds	$36,000 Operations and Maintenance Fund
Required Outside Agency Consultation	None
Priority with this OCP	O&M
Impact on Other Projects and on Overall Ecosystem Functions	Positive impacts on other landscape projects, increased wildlife habitat, conservation of water resources, and reduced erosion on barren ground.
Appendix Material	None

10.6.2.7 Tree City USA Designation

To be named a Tree City USA, Hickam AFB will need to establish a tree board or department and develop base regulations to serve as a tree ordinance. According to the Arbor Day Foundation, the base Environmental Protection Committee may serve as the tree board. Application to the Arbor Day Foundation must be routed for certification through the State Forester's office.

The cost estimate for this project is based on the assumption that the tree board will consist of ELC members and that Arbor Day observances will be staffed and organized by volunteers.

Project Name: Tree City Designation		
Affected Facilities	Hickam AFB	
Contribution to Management Goals and Objectives	Goal 6, Objective 3	This project will optimize protection and management of existing ecosystems while maintaining a visually attractive landscape for both Air Force personnel and the visiting public.
Land Management Goals and Objectives	Landscaped – High Maintenance Intensive Recreation	
Activities and Schedule	Establish tree board in 1998. Oversee preparation of an urban forest management plan following tree inventory. Plan annual Arbor Day observances. Complete project by 2007.	
Material and Labor Requirements	Materials: Arbor Day observance may include seedlings to plant, information brochures, etc. Labor: Natural Resources Manager, 120 hours; volunteers.	
Estimated Cost and Source of Funds	$18,000 Fee of $2 per capita for community forestry program (121,836 in 2000) would more than cover this cost for materials.	
Required Outside Agency Consultation	Application to National Arbor Day Foundation	

Priority with this OCP	Level 3
Impact on Other Projects and on Overall Ecosystem Functions	No impact on other projects. Increase environmental education for general public.
Appendix Material	None

10.6.2.8 Revegetation of Ammunition Storage and Training Areas

The ammunition storage area at the west end of the Prime BEEF area, as well as some of the training area itself, are sparsely vegetated and unsightly. Trees will be planted over approximately one-half acre in these areas to provide vegetative cover and enhance wildlife habitat and aesthetics. Flightline tree height restrictions and BASH issues will be accounted for in designing the planting plan, and consultation with 15 AW Flight Safety and APHIS Animal Damage Control is necessary. The plan should emphasize the use of native trees (e.g., fan palms, milo trees, kukui nut trees) wherever possible. It is likely that fertile topsoil will need to be imported to the site to enhance growing conditions, as the area has nutrient-poor soils.

The labor cost of about $4,800 assumes a landscape designer at $72/hr, backhoe operator at $48/hr, and tree planter at $24/hr. The remaining cost estimate of $19,200 is for materials.

Project Name: Revegetation of Ammunition Storage and Training Areas		
Affected Facilities	Hickam AFB	
Contribution to Management Goals and Objectives	Goal 6, Objective 1	The purpose of this project is to revegetate an unsightly, barren areas and enhance wildlife habitat.
Land Management Units	Intensive Training	
Activities and Schedule	Design planting plan by 2008; add topsoil and install plants following plan approval	
Material and Labor Requirements	Materials: small backhoe; up to 500 trees planted in groups on 10-15 foot centers; 400 yards topsoil; fertilizer. Labor: landscape designer, 30 hours; backhoe operator, 16 hours; tree planters, 80 hours.	
Estimated Cost and Source of Funds	Up to $24,000 O&M (most likely) ACES-PM, Conservation Resources Funding (potentially)	
Required Outside Agency Consultation	USDA APHIS Animal Damage Control for BASH.	
Priority with this OCP	O&M	
Impact on Other Projects and on Overall Ecosystem Functions	Will enhance aesthetics and urban wildlife habitat.	
Appendix Material	None	

10.6.2.9 Urban Forestry Management Plan

An urban forestry management plan will be prepared for Hickam AFB. This plan will include information from the tree inventory, such as species name

(common, scientific, and Hawaiian), size, relative age, condition, valuation, and maintenance requirements. In addition to the inventory information, the plan will develop more detailed urban forestry goals and objectives for Hickam AFB than are included in this INRMP. Based on the current status of the managed trees, certain areas or species may be emphasized for future plantings. More native species, as well as more drought-tolerant species, may be used in landscaping.

If the tree inventory begins in the highly visible street areas and in the historic districts, the urban forestry management plan can be undertaken concurrently with the tree inventory in the remaining community areas.

Depending on the software used in the inventory, certain tracking and trending components may be automatic. Scheduling and time accounting features will allow Hickam personnel to schedule maintenance, personnel needs, and budgets. Frequency reports will give statistical data on tree populations which will aid the base in detecting where species are not doing well or have been overplanted. Certain rare or exotic species can be highlighted and tracked, which may assist in the commercial forestry seed program.

Project Name: Urban Forestry Management Plan		
Affected Facilities	Hickam AFB	
Contribution to Management Goals and Objectives	Goal 6, Objective 2 Goal 6, Objective 5	This project will optimize protection and management of existing ecosystems by assessing the current species and establishing goals and objectives for the managed areas.
Land Management Units	Landscaped – High Maintenance Landscaped – Low Maintenance Intensive Recreation	
Activities and Schedule	Prepare urban forestry management plan following completion of some or all of the tree inventory. The plan may be prepared by subarea consistent with the urban tree inventory.	
Material and Labor Requirements	Materials: Rely on materials used for tree inventory, report production. Labor: urban forester, 400 hours at $108/hr; technical/clerical, 60 hours at $48/hr.	
Estimated Cost and Source of Funds	$48,000 ACES-PM, Conservation Resources Funding	
Required Outside Agency Consultation	None	
Priority with this OCP	Level 2	
Impact on Other Projects and on Overall Ecosystem Functions	No impact on other projects. The urban forestry management plan will be used in conjunction with the landscape design master plan.	
Appendix Material	None	

10.7 COMMERCIAL FORESTRY OPERATIONAL COMPONENT PLAN

Commercial forest land is defined in AFI 32-7064 (Attachment 1) as land on which forest trees of various sizes constitute at least 10 percent of the area. This category includes open land that is capable of supporting trees and is planned for forest regeneration and management. The smallest area for this classification is 5 acres. Roadside, streamside, and shelterbelt strips of timber must have or be capable of producing a crown width of at least 120 cubic feet to be classified as commercial forest. In addition, the Environmental Compliance and Management Program protocols require a forest management plan for installations with 50 acres of commercial forest. Based on these definitions and practical considerations (such as none of the 15 AW installations has 50 acres of commercial forest), the non-urban forested lands managed by 15 AW at the five installations included in this INRMP have no potential for producing commercial forest products and do not require forest management plans.

The primary guidance on forest management on Air Force lands, AFI 32-7064, states that non-commercial forested lands should be managed to control fires, disease, and insect attack, as well as enhancing other forest resource uses. Forests on Air Force lands are used for military training (e.g., Hickam AFB), or are preserved as wildlife habitat (e.g., Bellows AFS and Kokee AFS).

Although no traditional commercial forest products such as wood pulp and saw logs are economically plausible from the available forest resources, non-traditional products such as seeds may have value to local nurseries and gardening enthusiasts. Hickam AFB has a number of exotic plant species that are notable for their aesthetic value and rarity. These plants and others identified during the urban tree inventory (Section 10.6.2.2) will be managed for production of seeds that can be sold to local nurseries or provided free-of-charge to base personnel. This project can also be used as a public out-reach program, trading access to seeds for expertise and volunteer labor from local horticultural societies while helping to integrate on-base personnel and their families with the off-base community.

10.7.1 Implementation Summary for Commercial Forestry

Goal 7. Protect and improve the commercial forest resource.

Table 10.7-1 summarizes how each objective is to be implemented.

TABLE 10.7-1 IMPLEMENTATION SUMMARY FOR COMMERCIAL FORESTRY

Objective 7.1: Develop a program for managing the collection of seeds from selected trees and plants in landscaped areas of Hickam AFB.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Conduct a tree inventory, identifying species and harvest feasibility. Develop management directives for seed harvesting opportunities.	1. Implement Urban Tree and Plant Seed Harvest Project.	10.7.2.1	Hickam AFB

10.7.2 Operational Component Plan Project

One project is planned, and it depends on completion of the urban tree inventory. Interested horticultural groups should be contacted and enlisted for volunteer expert advice and labor. Species made available through seed sales or distribution should be screened based partially on their potential to become invasive and threaten native plant communities.

10.7.2.1 Urban Tree and Plant Seed Harvest

Project Name: Urban Tree and Plant Seed Harvest		
Affected Facilities	Hickam AFB	
Contribution to Management Goals and Objectives	Goal 7, Objective 1	The purpose of this project is to provide a source of seeds to on-base and off-base nurseries, horticulturalists, and gardening enthusiasts from rare exotic trees and plants while providing a small commercial revenue for use in offsetting the cost of administrating the project.
Land Management Units	Landscaped - Low Maintenance Landscaped – High Maintenance	
Activities and Schedule	Identify species and harvest feasibility by 2012.	
Material and Labor Requirements	Support Group, Civil Engineering, Operations Staff: 60 hours (see note). Materials will be derived from existing landscaping supplies.	
Estimated Cost and Source of Funds	$2,500 annually ACES-PM, Conservation Resources Funding (see note)	
Required Outside Agency Consultation	None	
Priority with this OCP	Level 3	
Impact on Other Projects and on Overall Ecosystem Functions	Successful implementation of this project may improve the aesthetic value of residential areas. This project relies on the tree inventory project to identify suitable trees for seed collection. Exotic species should not be propagated in areas planned for native plant restoration. Coordinate with DLNR to ensure that seed collecting does not result in spread of invasive species off-base.	
Appendix Material	None	
Note: This small-scale project will seek volunteer labor support from on-base gardening enthusiasts and off-base horticultural societies. Labor requirements are for administrating the project.		

10.8 OUTDOOR RECREATION AND PUBLIC ACCESS OPERATIONAL COMPONENT PLAN

The purpose of this Operational Component Plan is to identify projects that encourage utilization of the natural resources of lands managed by Hickam AFB for outdoor recreational purposes, while protecting and enhancing those resources. This plan supports the Air Force Services Agency mission by

promoting the well-being of base personnel through enhancement of outdoor recreation opportunities.

The outdoor recreation program must account for the basic requirements of healthy natural ecosystems while also coordinating with other mission activities. Lands used primarily for military activities, such as the airfield, are excluded from outdoor recreation uses for safety, public health, and security reasons. However, on lands that are considered multiple-use areas, outdoor recreation access may be alternated with scheduled military exercises to accommodate both types of uses. Prime outdoor recreation lands are not typically used for military training exercises unless no other sites are available to accommodate specific exercises (e.g., beach landing exercises at Bellows AFS). Similarly, outdoor recreation activities will be closely regulated (or prohibited) in the vicinity of sensitive natural ecosystems, such as wetlands or coral reefs.

Note that four of the five projects listed in this operational component plan are applicable to Bellows AFS as well as Hickam AFB. Coordination with MCBH staff on said projects is recommended to complement similar efforts on MCTAB.

Base Fishing Policy

A copy of the base fishing policy, which applies to Hickam AFB and Bellows AFS, is provided in Appendix U. Currently, fishing on base may be conducted only by those already authorized to be on the installation. Security Forces is responsible for enforcing this policy.

10.8.1 Implementation Summary for Outdoor Recreation and Public Access

Goal 7 Provide outdoor recreation opportunities that promote the mental, physical, and social well-being of base personnel, both military and civilian.

Table 10.8-1 summarizes how each objective is to be implemented.

TABLE 10.8-1 IMPLEMENTATION SUMMARY FOR OUTDOOR RECREATION AND PUBLIC ACCESS

Objective 8.1: Provide maximum outdoor recreational benefits within the constraints of the military mission and the capability of available resources, and preserve these resources for future generations.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Follow and update practices set in the Operational Component Plan for Outdoor Recreation and Public Access	1. Implement this OCP and update it at least every five years.	10.8	Hickam AFB Bellows AFS
Objective 8.1: Provide maximum outdoor recreational benefits within the constraints of the military mission and the capability of available resources, and preserve these resources for future generations.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**

Assess recreational needs and provide diverse recreational opportunities commensurate with installation resources, while preserving the military mission of the installations.	1. Implement Recreation and Environmental Education Needs Assessment Project.	10.8.2.1	Hickam AFB Bellows AFS
	2. Implement Shoreline Access/Interpretive Trails Project.	10.8.2.2	Hickam AFB Bellows AFS
	3. Implement Bird Watching Guide Project.	10.8.2.3	Hickam AFB Bellows AFS
	4. Implement Harbor Park Enhancement Project.	10.8.2.4	Hickam AFB
	5. Implement Trail Impact Monitoring and Maintenance Program.	10.8.2.5	Hickam AFB Bellows AFS
Objective 8.2: Provide fishing, picnicking, exercise trails, trail bicycling, and/or nature study opportunities, including a watchable wildlife program.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Assess recreational needs and provide diverse recreational opportunities which provide environmental education to recreation users.	1. Implement Recreational and Environmental Education Needs Assessment.	10.8.2.1	Hickam AFB Bellows AFS
	2. Implement Shoreline Access/Interpretive Trails Project.	10.8.2.2	Hickam AFB Bellows AFS
	3. Implement Bird Watching Guide Project.	10.8.2.3	Hickam AFB Bellows AFS
	4. Implement Harbor Park Enhancement Project.	10.8.2.4	Hickam AFB
	5. Implement Natural Resources Web Page Project.	10.2.2.4	All
	6. Implement Self-Guided Horticultural Interpretive Tour Project	10.6.2.5	Hickam AFB
Objective 8.3: Provide appropriate access to adjacent public lands and waters used for recreational purposes.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Support existing public access at Kokee AFS.	1. Continue honoring agreement with the State to provide access to hunters.	None	Kokee AFS
Assess needs and develop enhanced shoreline access opportunities where appropriate.	1. Implement Recreation and Environmental Education Needs Assessment.	10.8.2.1	Hickam AFB Bellows AFS
	2. Implement Shoreline Access/Interpretive Trails Project.	10.8.2.2	Hickam AFB Bellows AFS
Objective 8.4: Minimize impacts of recreational uses on natural resources in sensitive habitat areas.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**

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Provide trail impact monitoring and maintenance and annual reef cleanup to reduce current recreational impacts. Encourage users to stay on trails and sites constructed for recreational use.	1. Implement Shoreline/Access Interpretive Trails Project	10.8.2.2	Hickam AFB Bellows AFS
	2. Implement Trail Impact Monitoring and Maintenance Project	10.8.2.5	Hickam AFB Bellows AFS
	4. Implement Ahua Reef Cleanup Project	10.10.2.2	Hickam AFB

10.8.2 Operational Component Plan Projects

The plan includes five projects which are designed to enhance or increase outdoor recreational opportunities and/or minimize impacts to natural resources from recreational activities. None of the projects is needed immediately to correct environmental compliance problems. The needs assessment should be completed as soon as possible to guide implementation projects in this and in other operational component plans with environmental education projects. Each project meets one or more of the objectives listed above (Section 10.8.1). The projects are summarized in tabular form and explained in greater detail in the text accompanying each table. As noted in these tables, some projects meet objectives of other OCPs but are included in this section because they primarily address outdoor recreation objectives.

The recreation and public access projects discussed in this section are:

- Level 2
  -Recreation and Environmental Education Needs Assessment
- Level 3
  -Shoreline Access/Interpretive Trails
  -Bird Watching Guide
- No ACES-PM Priority
  -Harbor Park Enhancement
  -Trail Impact Monitoring and Maintenance Program

10.8.2.1 Recreation and Environmental Education Needs Assessment

Crowding and the poor condition of facilities are recurring themes mentioned in the Hickam AFB Outdoor Recreation Plan (15 ABW 1995b). Conducting a recreation and environmental education needs assessment would demonstrate Air Force responsiveness to these issues by determining user preferences for various types of recreation facilities, trails, and programs. The assessment would help focus limited funding on the recreation projects described above that are most important from the users' perspective. Results of the assessment may alter the project priorities presented in this document. The assessment would be comprehensive in that it would broaden its focus to include recreation needs at Bellows AFS, and most likely would collect detailed information.

One portion of the recreation and environmental education needs assessment would focus on users' needs for recreation facilities and trails, while the other portion would

gauge users' knowledge of the marine/coral reef environments, and query users about the types of environmental education programs in which they would most likely participate. The first part of the survey would ask users about general recreation preferences and gauge their support for the projects mentioned in this OCP (Projects 10.8.2.2-10.8.2.5). The second part of the survey would test users' knowledge about basic ecological concepts relevant to marine and coral reef environments, and other local ecosystems. This information could be used to identify topics or issues where educational efforts are needed.

The cost estimate below assumes the following labor rates for non-Air Force personnel: biologist, $96/hr; recreation planner, $84/hr; statistician, $84/hr; graphic artist, $60/hr, and technician/clerical, $48/hr.

Project Name: Recreation and Environmental Education Needs Assessment		
Affected Facilities	Hickam AFB, Bellows AFS	
Contribution to Management Goals and Objectives	Goal 8, Objective 1 Goal 8, Objective 2 Goal 8, Objective 3	Completing this project would prioritize projects desired by recreation users, and focus attention and funding on the most important projects.
Land Management Units	All MEAs except BASH Reduction	
Activities and Schedule	Determine the user population of interest, develop needs assessment survey, implement survey, and summarize findings. Select contractor and develop survey methods in 2009, then implement in 2010.	
Material and Labor Requirements	Materials: $360 Labor: Recreation Managers at Hickam and Bellows, 100 hours; biologist, 40 hours; 2 recreation planners and statistician, 600 hours; graphic artist, 50 hours; technician/clerical, 50 hours.	
Estimated Cost and Source of Funds	$60,000 AFSA Fund; ACES-PM, Conservation Resources Funding	
Required Outside Agency Consultation	Although not required by law, the National Park Service does consult and advise the Air Force on recreation issues.	
Priority with this OCP	Level 2	
Impact on Other Projects and on Overall Ecosystem Functions	No major impact on other projects. Completing this project will allow early coordination with the Base Natural Resource Manager to determine the best way to minimize or mitigate resource impacts as recreation projects are implemented.	
Appendix Material	None	

10.8.2.2 Shoreline Access/Interpretive Trails

Two interpretive kiosks are located at either end of the Fort Kamehameha shoreline (15 ABW 1995b). These kiosks include photographs and information on the nearby wetland flora. The kiosks are the first phase of a planned interpretive trail that will meander through the more open areas of the nearby shoreline wetland reserve, providing access to sandy beach areas to the northwest of the wetland (see Outdoor Recreation Plan for Hickam AFB, Figure 3-4, for proposed trail location and Figure 10-3 in this INRMP for project location). Ten interpretive signs addressing various aspects of local

ecosystems have already been installed along the trail location. Trail length will total approximately one-third mile, and portions crossing wetland, areas will consist of raised wooden walkways that are designed to be aesthetically pleasing and will be structurally sound and fully accessible to disabled visitors. This raised structure will minimize wetland impacts.

The cost estimate is based on the assumption of $36,000 per mile for the trail with wooden walkways. If base employees assist in trail construction, this cost would be reduced.

Project Name: Shoreline Access/Interpretive Trails		
Affected Facilities	Hickam AFB	
Contribution to Management Goals and Objectives	Goal 1, Objective 1 Goal 3, Objective 2 Goal 5, Objective 5 Goal 6, Objective 6 Goal 8, Objective 1 Goal 8, Objective 2 Goal 8, Objective 3 Goal 8, Objective 4 Goal 10, Objective 2	This project would result in a walking trail that: - provides fishing/walking access to stream and marine shoreline areas - reduces ongoing wetland impacts from people seeking shoreline access - provides wetland and shoreline birdwatching opportunities - provides educational information about mangrove wetland and coral reef ecosystems
Land Management Units	Natural Resources Multiple Use Hickam AFB: Ahua Reef and shoreline wetlands	
Activities and Schedule	Develop detailed scope of work by 2009, complete trail construction by 2012. Construct raised boardwalk where trail crosses wetland areas.	
Material and Labor Requirements	1 project manager, 50 hours; 3 construction laborers, 250 hours; 1 biologist, 50 hours; 1 landscape architect, 50 hours.	
Estimated Cost and Source of Funds	$60,000 ACES-PM, Conservation Resources Funding	
Required Outside Agency Consultation	U.S. Army Corps of Engineers should be consulted whenever planning construction in wetlands to confirm compliance with section 404 of Clean Water Act.	
Priority with this OCP	Level 3	
Impact on Other Projects and on Overall Ecosystem Functions	Some minor wetland impacts may occur during construction, but project will reduce long-term impacts due to shift from current unmanaged transition managed trails. Coordinate with Riparian Enhancement Project.	
Appendix Material	None	

10.8.2.3 Bird Watching Guide

A bird watching field guide for Hickam AFB and Bellows AFS will be developed to encourage base users to become familiar with locally common birds and their habitats. The guide will include a photo of each bird and diagrams of identifying characteristics. Information on habitat, food items, nesting habits, migration

patterns, and distinctive calls will be presented. Maps of each base showing prime bird habitat and locations of interpretive trails and other good bird watching sites will be included. This information could be added to the Natural Resources Web Page and periodically updated or supplemented.

Project Name: Bird Watching Guide		
Affected Facilities	Hickam AFB, Bellows AFS	
Contribution to Management Goals and Objectives	Goal 1, Objective 1 Goal 5, Objective 5 Goal 8, Objective 1 Goal 8, Objective 2	This project would provide a field guide to base users to help them identify and learn about birds common to the areas around Hickam AFB and Bellows AFS.
Land Management Units	All MEAs	
Activities and Schedule	Research and complete guide; include photos/drawings of common species, species descriptions, habitat descriptions, natural history information, and maps showing prime bird viewing areas by 2012.	
Material and Labor Requirements	Material: printing, $3,000. Labor: project costs assume use of volunteer labor to provide bird photos, and drawings, illustrations, and assembly. Volunteers could also enter the information on the web page.	
Estimated Cost and Source of Funds	$3,000 ACES-PM, Conservation Resources Funding	
Required Outside Agency Consultation	None	
Priority within this OCP	Level 3	
Impact on Other Projects and on Overall Ecosystem Functions	Supplements other Watchable Wildlife projects (10.8.2.2 and 10.8.2.4). Will educate public on value of local wildlife habitats and encourage responsible use of environment.	
Appendix Material	None	

10.8.2.4 Harbor Park Enhancement

Harbor Park would significantly benefit from the extensive landscaping that is planned for this area. The existing conceptual plan includes two baseball diamonds, three tennis courts, a number of volleyball courts, parking areas, and numerous trees and shrubs (15 ABW 1995b). The area adjacent to Honeymoon Beach is particularly barren and unattractive; it could be enhanced by planting sheltering trees and seeding grass. Because this is not one of the high visibility areas that would typically be planted with showy flowering plants, landscape designers should experiment with finding native plant species that will thrive here. Plants that will not require significant amounts of fertilizer should be chosen, given the proximity of the area to the shoreline. It will be necessary to add 6-12 inches of topsoil in most of the area adjacent to Honeymoon Beach in order to establish healthy plant growth.

The cost estimate assumes contractor support for the following positions: landscape architect at $120/hr, graphic artist at $60/hr, construction project manager at $60/hr, and laborers at $36/hr. Other materials and equipment usage costs may be as much as two-thirds of the total cost. The estimate does not include ongoing maintenance for new landscaping.

Project Name: Harbor Park Enhancement		
Affected Facilities	Hickam AFB	
Contribution to Management Goals and Objectives	Goal 8, Objective 1 Goal 8, Objective 2	This project would enhance the recreational experience at Hickam Harbor and Honeymoon Beach by improving the landscaping and by adding athletic fields.
Land Management Units	Intensive Recreation	
Activities and Schedule	Develop detailed scope of work and site plan based on conceptual plans in Outdoor Recreation Plan by 2009, complete landscaping and installation of recreational facilities by 2011.	
Material and Labor Requirements	Base Recreation Manager, 80 hours; landscape architect, 250 hours; graphic artist, 60 hours; construction project manager, 400 hours; construction laborers, 2,000 hours.	
Estimated Cost and Source of Funds	$360,000 Air Force Services Agency Funding	
Required Outside Agency Consultation	The State may ask for a Section 401 Water Quality Certification; Section 404 permit may be needed from USACOE	
Priority with this OCP	No applicable ACES-PM Priority.	
Impact on Other Projects and on Overall Ecosystem Functions	No impact on other projects. Landscape plantings will reduce runoff and sediment loading in adjacent water bodies and also enhance habitat for urban wildlife species in currently barren areas.	
Appendix Material	None	

10.8.2.5 Trail Impact Monitoring and Maintenance Program

Heavy trail use or trail use during the rainy season can have substantial impacts on sensitive environments. Impacts include soil erosion, vegetation trampling, and changes in water quality due to increased sedimentation. Impacts can be mitigated by regular trail maintenance and by regulation of recreation use during wet periods. However, mitigation is dependent upon early detection of trail impacts and on determining whether impacts are severe enough to require management actions. This project would ensure early detection through regular monitoring of trail conditions. If unacceptable impacts are found, then decisions can be made to implement actions such as accelerated maintenance, temporary trail closures, or trail rerouting. Monitoring would involve regularly recording information on trail width, depth, evidence of gullying, braiding (i.e., creating multiple trails), and numbers of trees with exposed roots along selected lengths of trail. If conditions warranted seasonal closure of trails, monitoring would also include determining whether any inappropriate use is occurring during the closure period.

Trail maintenance can greatly reduce impacts. Trail maintenance includes activities such as cleaning out debris and soil from water bars and dips, replacing bridges and other structures (such as boardwalks), and clearing "blowdown" from the trail. At a minimum maintenance should occur twice a year, prior to and after the wet season to ensure drainage structures are functioning properly. If trail use is permitted during the wet season, additional maintenance will be required during that time. Implementing a monitoring program will allow the Air Force recreation and natural resource managers to assess whether more or less maintenance is required than the current level of effort to protect soil resources.

Trails that should be monitored and maintained include the trails near the beach at Bellows AFS, the existing trail into the shoreline wetland at Hickam AFB, proposed interpretive trails, and other trails that receive significant foot or bicycle traffic.

Project Name: Trail Monitoring and Maintenance Program		
Affected Facilities	Hickam AFB, Bellows AFS	
Contribution to Management Goals and Objectives	Goal 3, Objective 2 Goal 4, Objective 1 Goal 8, Objective 1 Goal 8, Objective 4	Keeping trails in good condition will prevent the need to close trails for extended periods of time, thereby maintaining a higher level of visitor satisfaction. Ensuring trails are well drained and free from blow-down will keep users from trampling sensitive vegetation adjacent to the trail, and will minimize sedimentation to watercourses.
Land Management Units	Natural Resources Multiple Use Watercourse	
Activities and Schedule	Work with base recreation personnel to identify trail maintenance problems, develop a monitoring form, test it with recreation/natural resource technicians, and test monitoring form to make sure it is useable.	
Material and Labor Requirements	To initiate the project, 15 CES would need to hire a trail planning specialist to develop and test the monitoring program. Implement by 2012.	
Affected Facilities	Hickam AFB, Bellows AFS	
Estimated Cost and Source of Funds	$24,000 the first year. Approximately 40 percent of costs are for an outside consultant. Annual costs after the first year of $14,500 to monitor trail impacts two times a year, and conduct maintenance twice a year. Morale Welfare Recreation Fund	
Required Outside Agency Consultation	None	
Priority with this OCP	No applicable ACES-PM priority.	
Impact on Other Projects and on Overall Ecosystem Functions	There would be positive impacts as a result of implementation. Soil erosion and other trail impacts would be greatly reduced.	

Appendix Material	None

10.9 OUTLEASING FOR NATIVE PLANT HORTICULTURE OPERATIONAL COMPONENT PLAN

10.9.1 Outleasing for Native Plant Horticulture

This project will create a nursery to be privately operated in which native plant species are grown for the purpose of transplanting them to landscape plantings, former IRP sites, barren areas, habitat enhancement plantings, and other sites. The nursery will help natural resource managers actively increase the number of native plant species on Air Force lands, thus enhancing wildlife habitat and reducing grounds maintenance requirements. The native stock raised in the nursery will come from three primary sources: (1) seeds that are either purchased or collected from plants growing on Air Force lands, (2) young starts purchased from local nurseries, and (3) plants removed from planned development sites on Air Force lands.

Potential nursery sites include two areas at Hickam AFB and one at Kipapa FSA as follows:

1. an open grassy area along the east boundary of Hickam AFB, to the south of the Magazine Area, just north of Taxiway A (currently used as dogwalking and recreational area)
2. a barren area near the southeast corner of Hickam AFB, just east of Manuwai Canal and north of Worchester Avenue
3. the grassy area within the fence near the old office building on Kipapa FSA.

Waikakalaua FSA may also be a potential site for a nursery if the facility is not used for agricultural or other uses.

The Base Landscape Designer will evaluate and select one or more of these sites.

The lessee will maintain the nursery and will sell the plants for commercial gain to the Air Force and to the general public. The revenue gained from the lease could offset some of the cost of landscaping or revegetation projects. Another option would be to sell the land (Kipapa FSA) to a private entity for agricultural use. If Waikakalaua FSA is not used for an agricultural outlease, it may be available for a native plant nursery.

Agricultural outleasing would require an Environmental Impact Assessment Process action (NEPA). Costs associated with this action are pending.

Project Name: Outleasing for Native Plant Horticulture		
Affected Facilities	Hickam AFB, Kipapa FSA, Waikakalaua FSA	
Contribution to Management Goals and Objectives	Goal 2, Objective 6 Goal 6, Objective 7 Goal 9, Objective 1	The purpose of this project would be to outlease Air Force lands for private citizens to create a native plant nursery. This nursery would

		sell plants commercially and could supply the Air Force with needed plants for landscaping, revegetation, and habitat enhancement projects.
Land Management Units	Natural Resources Multiple Use Landscaped – High Maintenance Landscaped – Low Maintenance Intensive Recreation	
Activities and Schedule	Make lands available for outlease, and develop outlease agreement by 2012.	
Material and Labor Requirements	Lessee would provide all necessary materials. Air Force would make existing water sources available. Air Force labor would only entail agreement oversight.	
Estimated Cost and Source of Funds	Revenue from outlease would offset minor labor cost and result in net profit for Air Force to offset other project costs.	
Required Outside Agency Consultation	Consultation with City and County of Honolulu regarding proposed change in land use from military to agricultural is recommended to ensure compatibility with adjacent off-base land uses. Coordination with state or local native plant societies is recommended.	
Priority with this OCP	Level 3	
Impact on Other Projects and on Overall Ecosystem Functions	This project would have a positive impact on vegetation and wildlife enhancement projects.	
Appendix Material	None	

10.10 COASTAL RESOURCES OPERATIONAL COMPONENT PLAN

This operational component plan focuses on measures to protect coastal resources at Hickam AFB and Bellows AFS. There is some overlap between measures here and those in Section 10.4, Watershed Protection.

State Regulations

The State of Hawaii recognizes three zones developed from regulations enacted in 1970, 1975, and 1977 (State of Hawaii 1991).

- A 20- to 40-foot shoreline setback was enacted by the Hawaii Land Use Law in 1970 and later transferred to the Coastal Zone Management Law in 1986. No structures are permitted between the setback line and shoreline without a variance from the county (Honolulu).
- In addition to the shoreline setback, the Shoreline Protection Act of 1975 designated all lands within 100 yards of the shoreline, or a watercourse subject to salinity intrusion, as a special management area requiring county approval for a permit to develop the land. Consequently, this zone includes a substantial portion of the watercourses found at Hickam AFB and Bellows AFS and adjacent lands extending 100 yards from their banks.

- The Coastal Zone Management Program (CZMP) was first created in 1977 and approved by the federal government in 1978. Due to Hawaii's geographic nature (islands), the coastal zone area includes all lands, plus waters extending to the limit of state jurisdiction. However, any "lands owned, leased, held in trust, or otherwise subject solely to the discretion of the federal government" (State of Hawaii 1990) are administratively excluded from the coastal zone.

Federal Legislation

Despite this exclusion, the national Coastal Zone Management Act of 1977 requires that direct federal activities be consistent with state programs "to the maximum extent practicable" and are subject to review by the state Office of Planning (OOP; Department of Business, Economic Development, and Tourism). In addition, projects requiring federal licenses and permits, or that apply for federal assistance grants, are also subject to consistency review, but to a lower standard than direct activities. Consequently, the Air Force will submit consistency determinations for all development activities to the OOP for review and. consider modifications to action plans if the OOP does not concur with the determination.

The Air Force has agreed to coordinate activities and cooperate with the Coastal America National Implementation Team created as part of the Coastal America Initiative. According to the 1994 Coastal America Progress Report, their purpose is to "(1) protect, preserve, and restore the Nation's coastal ecosystems through existing Federal capabilities and authorities; (2) collaborate and cooperate in the stewardship of coastal living resources by working together and in partnership with other Federal programs, and by integrating Federal actions with state, local, tribal government, and non-governmental efforts; and (3) provide a framework for action that effectively focuses expertise and resources on jointly identified problems to produce demonstrable environmental and programmatic results that may serve as models for effective management of coastal living resources." All of the projects included in this operational component plan comply with Coastal America goals and should be reported to the Coastal America Regional Implementation Team (Pacific Islands).

10.10.1 Implementation Summary for Coastal Resources

10.10.1 Implementation Summary for Coastal Resources

Goal 10: ***Protect, maintain, and improve marine resources and coral reefs.***

Table 10.10-1 summarizes how each objective is to be implemented.

TABLE 10.10-1 IMPLEMENTATION SUMMARY FOR COASTAL RESOURCES

Objective 10.1:	**Enhance the health and biodiversity of coral reefs and shoreline areas by limiting freshwater inputs of pollution and sediment**

Implementation Process	Project/Action	Report Section	Applicable Installations
Determine the level of contaminants in sediments and develop a removal plan.	1. Implement Watercourse Sediment Removal Feasibility Study.	10.4.2.1	Hickam AFB
Identify the sources of sediment pollution and reduce impacts from riparian zone activities at Bellows AFS. Control pesticide, herbicide, and fertilizer use at Hickam AFB and Bellows AFS.	1. Implement the Riparian Enhancement Project.	10.4.2.2	Bellows AFS
	2. Follow BMPs on use of pesticides, herbicides, and fertilizers near streams and canals.	Appendix F	Hickam AFB Bellows AFS
Reduce pollutant load on coral reefs and shoreline areas at Hickam AFB	1. Implement the Pollution Prevention Management Plan for Hickam AFB.	None	Hickam AFB
Objective 10.2: Enhance the value of the reef to both on-base and off-base recreational users, including the harvest of marine species, through environmental education programs.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Provide environmental education opportunities regarding coral reef value I developing shoreline access and a Web Page. Reduce recreational impacts on Ahua Reef.	1. Implement Shoreline Access/Interpretive Trails Project.	10.8.2.2	Hickam AFB
	2. Implement Natural Resources Web Page Project.	10.10.2.4	All
	3. Implement Ahua Reef Cleanup Project.	10.10.2.2	Hickam AFB
Require boaters at Hickam Harbor to follow proper fuel and boat maintenance BMPs for users.	1. Implement the Boat BMP Signs Project.	10.10.2.1	Hickam AFB
	2. Include BMPs in lease agreement with concessionaire who operates harbor facilities.	None	Hickam AFB
Objective 10.3: Coordinate and monitor ship channel and beach maintenance activities with the U.S. Navy and the U.S. Army Corps of Engineers by establishing points-of-contact and ongoing communications.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Develop lines-of-communication with the appropriate branches of the Armed Forces.	1. Consult list of agency contacts; update list regularly. Provide review and comment on ship channel and beach maintenance work efforts.	Appendix I	Hickam AFB
Determine the impacts of dredging ship channels.	1. Make general observations of silt plumes during dredging operations to determine if impacts may be occurring, or if additional studies should be	None	Hickam AFB

	considered.		
Objective 10.4: Survey and monitor the presence and abundance of marine species on coral reefs. Work with local interest groups, the U.S. Navy, and the U.S. Marine Corps to compile and exchange data.			
Implementation Process	**Project/Action**	**Report Section**	**Applicable Installations**
Update the marine species identification list.	1. Implement Monitoring Surveys Project.	10.2.2.5	Hickam AFB Bellows AFS
Initiate discussions with each DoD agency.	1. Consult list of agency contacts, update list regularly.	Appendix I	Hickam AFB Bellows AFS
Participate in local conferences on marine health.	1. Same as process	None	Hickam AFB Bellows AFS
Develop lines-of-communication with the Coastal America Regional Implementation Team.	1. Report coastal activities to the Coastal America Regional Implementation Team.	10.10	Hickam AFB Bellows AFS

10.10.2 Operational Component Plan Projects

The Operational Component Plan for Coastal Resources includes contributions from eight projects. Of these, two are Level 1, or first priority, (to begin in 2008). The rest of the projects are either Level 3 or "unknown" priority. All prescribe activities which contribute not only to Goal 10 objectives but also to other goals and objectives. The following projects help to reach Goal 10 objectives:

- Level 1
  -Monitoring Surveys
- Level 3
  -Shoreline Access/Interpretive Trails
  -Boat BMP Signs
  -Ahua Reef Cleanup
  -Natural Resources Web Page
  -Riparian Enhancement
- Unknown
  -Watercourse Sediment Removal Feasibility Study

The Boat BMP Signs and Ahua Reef Cleanup projects are fully described in this section. The remaining projects were described in earlier sections and are summarized here with references to the full description.

10.10.2.1 Boat BMP Signs

Boat launch and docking facilities are currently available at Hickam Harbor. Boat maintenance and fueling activities can be significant contributors to coastal pollution. Anchors can damage the coral reef. The Boat Best Management Practices (BMP) Sign Project is developed to inform boaters about BMPs to be followed during boating activities. The sign(s) can also

inform boaters about proper anchoring techniques to avoid damage to coral reefs, nearby hazards, and regulations and include courtesy suggestions related to non-motorized shoreline and watersport activities. Boat renters should be provided with pamphlets outlining these BMPs during preparation of their renter's agreement and verbally asked to follow recommended procedures. The concessionaire who operates the harbor must be required to implement BMPs through the signs and pamphlets. The BMPs need to be part of the lease agreement to help ensure that they are followed or the lessee risks losing the concession.

The cost estimate below assumes labor rates of $60/hr for graphic artist, $48/hr for carpenter, and $60/hr for the Harbor Master. It does not include cost for the natural resources manager.

Project Name: Boat BMP Signs		
Affected Facilities	Hickam AFB	
Contribution to Management Goals and Objectives	Goal 2, Objective 3 Goal 10, Objective 2	The purpose of this project is to create and post educational signs at Hickam Harbor describing BMPs for fueling boats and for boat maintenance.
Land Management Units	Intensive Recreation Natural Resources Multiple Use.	
Activities and Schedule	Complete project in 2009.	
Material and Labor Requirements	Material: $9,600; Labor: graphic artist, 80 hrs; carpenter, 20 hrs; Harbor Master, 20 hrs; Natural Resources Mngr, 8 hrs;.	
Estimated Cost and Source of Funds	$16,560 ACES-PM, Conservation Resources Funding	
Required Outside Agency Consultation	None	
Priority within this OCP	Level 3	
Impact on Other Projects and on Overall Ecosystem Functions	BMP education will help prevent water quality degradation from petrochemical pollution and reduce damage to coral reefs from improper anchoring.	
Appendix Material	None	

10.10.2.2 Ahua Reef Cleanup

Scuba diving and snorkeling are popular sports in Hawaii, and Hickam AFB has an on-base club for enthusiasts. Field surveys have indicated that ghost fishing gear from both land- and boat-based fishermen have impacted fish and green sea turtles utilizing the reef. These impacts are of particular concern to green sea turtles, because they are listed as threatened by the NMFS. The Ahua Reef Cleanup Project is designed to utilize the scuba club as a resource for improving reef conditions by removing abandoned gill nets, fishing gear and other debris. The Air Force, their guests, and the general public (via boat) all utilize the resources at Ahua Reef. Consequently, this project is also an opportunity for military personnel to interact with the general public on Oahu by inviting off-base scuba clubs to participate in the reef's cleanup on an annual basis.

The cost estimate below assumes that volunteers will clean the reef. The $600 materials estimate is for a "volunteer guidance" handout (to be prepared by the natural resources manager with help from scuba divers) and cold drinks. The cost could be reduced by having a local business sponsor the event with the Air Force.

Project Name: Ahua Reef Cleanup		
Affected Facilities	Hickam AFB	
Contribution to Management Goals and Objectives	Goal 2, Objective 2 Goal 2, Objective 3 Goal 8, Objective 4 Goal 10, Objective 2	The purpose of this project is to sponsor and motivate the on-base scuba club to clean derelict fishing gear from Ahua Reef and provide education to members about its impact to divers and the general public.
Land Management Units	Natural Resources Multiple Use Hickam AFB – Ahua Reef	
Activities and Schedule	Prepare volunteer guidance handout in 2009 and conduct cleanup on an annual basis	
Material and Labor Requirements	Natural Resources Manager, 4 hours annually; Assistant Natural Resources Manager, 40 hours annually.	
Estimated Cost and Source of Funds	$600 annually ACES-PM, Conservation Resources Funding (see note)	
Required Outside Agency Consultation	DLNR and NMFS should be informed of the activities and invited to participate, but consultation is not required.	
Priority within this OCP	3	
Impact on Other Projects and on Overall Ecosystem Functions	No impact on other projects. This should help to improve the health of the coral reef and help protect threatened green sea turtles.	
Appendix Material	None	
Note: Resource manager salary not included. Coordinate and collaborate with off-base scuba clubs.		

10.10.2.3 Public Education

The education of visitors to the Hickam AFB shoreline can help to improve habitat conditions at Ahua Reef. Two projects, the Shoreline Access/Interpretive Trails (Section 10.8.2.2) and the Natural Resources Web Page (Section 10.2.2.4), are designed to help educate visitors about coral reef ecosystems, their fauna, and activities that can result in positive or negative impacts to the reef. The shoreline trail at Hickam AFB is situated at the high value wetlands (wetland reserve) along the shoreline next to Ahua Reef, and it includes educational signs (or kiosk) for both wetland and marine ecosystems. Information presented on signs can also be provided on the Natural Resources Web Page which would inform base residents about access to the trail.

10.10.2.4 Watercourse Sediment Removal Feasibility Study

The Watercourse Sediment Removal Feasibility Study is for management of watercourses at Hickam AFB. This study will determine the current level of hazardous materials within sediments found in the watercourses and provide managers with sufficient information to determine if rehabilitation and cleanup projects are warranted. Sediments within the canals can be transported to coastal waters during extreme floods or other stream channel disturbances. In addition, juvenile marine fish are known to use brackish regions for rearing. The cleanup projects may include dredging and removal of contaminated sediments, which would require a permit from the USACOE and construction oversight from an archaeologist to ensure that the removal activity would not disturb Native Hawaiian remains or artifacts. A description of the Watercourse Sediment Removal Feasibility Study can be found in Section 10.4.2.1.

10.10.2.5 Monitoring Surveys

Surveys conducted during the preparation of this plan have documented the type of marine habitats present offshore of Hickam AFB and Bellows AFS and the abundance and diversity of the fauna using these habitats. However, periodic surveys in the future are required to detect positive or negative changes to the marine resources to help managers determine if current activities should be modified or ended, or if new activities and enhancement projects are required. The Monitoring Surveys Project is designed to meet this need. The project is described more fully in Section 10.2.2.5.

10.10.2.6 Riparian Enhancement Project

An important component to protecting water resources that contribute to coastal waters is implementation of a riparian buffer zone, i.e., a strip of land from the bank of the stream inland that buffers the stream from a variety of activities. Reduction or elimination of activities in the riparian zone can reduce the level of negative impacts to a stream. Riparian vegetation provides stream bank stability, shade, cover, and nutrients to a stream and its aquatic fauna. Degradation of the riparian zone can lead to increased erosion, warmer stream temperatures, and other impacts. This INRMP recommends a minimum 35-foot riparian buffer strip along each watercourse bank (Bay Pacific Consulting 1996), except along small tributary ditches that are part of the Hickam stormwater canal system. The Watercourse MEA uses this 35-foot buffer.

10.11 GEOBASE OPERATIONAL COMPONENT PLAN

The 15th Airlift Wing needs to ensure that the existing GeoBase program utilizing Environmental Systems Research Inc. (ESRI) format is used as an integral part of natural resources management. Currently, GeoBase viewers have the capability of viewing graphical features and data through a network version of the ArcMap software program version 9.1. This software has a suite of tools that can be used to enter, access, analyze, and plot mapped natural resources data. The natural resources data represents a substantial set of baseline information. The natural resources data set contains layers such as soils, wetlands, recreational areas, hydrography, floodplains, vegetation cover, turfgrass areas, and other resources. In addition, the opportunities and constraints and MEA maps included in this document are now in the appropriate Spatial Data Standards (SDS) layers in geodatabases.

Opportunities for collaboration with neighboring installations such as MCTAB should be explored when considering funding for projects such as new aerial photography, for example. Sharing of natural resources data should also be considered to help ensure success of complementary INRMP projects.

10.11. 1 Hickam AFB GeoBase Implementation

Goal 11: ***Use natural resources maps and databases contained in GeoBase to assist in environmental management.***

Geodatabase layers are valuable for managing wetland protection, NEPA review, monitoring implementation, and T&E enhancements, and they quickly provide measurements and maps for general use. Related potential uses include planning for a future GIS internet-based solution (ArcIMS), making information on resources and plans implementation available at the Base Commander's or other networked computers on the base LAN, and having ready-to-go graphics available for special presentations or reporting and coordination needs. The OCP for GeoBase makes this data more accessible.

The projects, when implemented, will involve the natural resources manager in the day-to-day use of GeoBase. Under PACAF's' mandate the GIS administrator is a certified ESRI instructor and has provided ArcMap training to numerous Civil Engineer personnel, and other Hickam organizations. This has given many returns on PACAF's investment on GeoBase.

10.11. 2 Operational Component Plan Projects

Each geodatabase has been derived from specific sources. The scale, accuracy, content, and date of each source is important and says a great deal about the reliability and usability of the resulting data layers. For example, one wetlands data-layer is from the National Wetlands Inventory (NWI), while the other was prepared to represent jurisdictional wetlands using USACOE criteria. Other detailed wetlands delineations should be included in the data set when completed. Updates such as these will become a part of the updates for the natural resource management and form the basis for one of the projects listed below.

The mandate of the GeoBase section is to maintain and update geodatabases in accordance with Spatial Data Standards (SDS) as established by the CADD/GIS Technology Center (https://tsc.wes.army.mil). Each data layer must be maintained in the proper geodatabase. This is the standard of how layers are named where layers will reside. Each geodatabase is compromised of an entity set, and then broken into an entity class and entity type. Layers that do not have an existing SDS layer are referred to the GeoBase section for a non-SDS geodatabase. The current guidance for GeoBase is outlined in a document titled "Interim USAF GeoBase Concept of Operations" dated Jan 2002 and prepared by the Headquarters Air Force Geo Integration Office. This document is available in a Portable Document Format File (3632133072002geo.pdf) at https://www.il.hq.af.mil/GeoBase/. Minimum standards are outlined in the Concept of Operations concerning minimum standards of imagery, coordinate system, projection, and units used. It is important to remember that higher resolution provides better detail for mapping but costs more to produce. The maintenance plan for each data layer will dictate many of this project's activities.

Updated geodatabases should be used to support coordination, planning, analysis, and documentation functions of base personnel. OCP projects will greatly improve data accessibility and provide for a cost-effective approach to expanding the user base and practical applications of GeoBase. As GeoBase viewers gain an understanding of the powers of the system and achieve some facility in applying it, the quality and efficiency of tasks such as NEPA review will improve. Similarly, new applications of the information will become evident, from simply compiling and planning maintenance needs (e.g., miles of fenceline to be replaced, or roadside to be mowed), to displays for public relations or agency consultation purposes. The projects described in this OCP will provide the framework and support systems necessary for use of GeoBase both as a natural resources management tool and as the basis for useful and creative future applications.

None of the five projects included in this operational component plan has an ACES-PM priority level. Consequently, the projects are listed below in order of their potential timing, assuming that the first project could begin in fiscal year 2008 with appropriate funding, sources outside of the ACES-PM Conservation Resources Fund.

- Internet Based GeoBase Implementation (ArcIMS)
- Data Integration and Accessibility
- New Aerial Photography and Photogrammetry (only Kokee AFS)
- Update Process for Natural Resource Data Layers
- Additional Natural Resource Layers and Applications

The first three are tentatively planned for implementation between 2008 – 2010 by the GeoBase section. The last two may be scheduled for implementation between 2011 and 2012, depending on the availability of funding.

10.11.2.1 Internet-Based GeoBase Implementation (ArcIMS)

Currently, the natural resources geodatabases are accessible to the entire Environmental Flight through the network version of ArcMap. The use of

ArcMap software requires training and consistent use to achieve competency. The capability of viewing graphical features and attached data to perform analysis is by far simplified with an internet-based solution (such as ArcIMS). Data in ArcIMS is read only thus safeguarding critical data to administrators or properly trained personnel. Upon implementation and testing of ArcIMS an orientation course is the most common and cost-effective way to disseminate the use of the ArcIMS program. It is recommended the GeoBase administrator perform necessary training on the use of ArcIMS for the majority of 15 CES personnel, and other personnel from other organizations and Wing units on the use of ArcMap.

Personnel that need access to view data shall be required to have a valid login and password from the ArcIMS administrator. Maps created in the ArcIMS web site should follow the format of tabs as depicted in AFI 36-7062 (Air Force Comprehensive Planning). Other map requirements that fall outside the AFI shall be require a custom map request to the GeoBase section. Currently, there are only two approaches for a viewer to access the information within GeoBase:

- The first approach is to have requests submitted to the GeoBase section. Requests for maps, acreage calculations, and other queries can be quickly processed by any of the GeoBase staff as well as the military Engineering Assistants in the Engineering Flight that have received ArcMap training.
- The second approach is for a viewer to access the GeoBase from their desktop computer by utilizing the network version of ArcMap. Data and imagery files are then copied to the viewers local hard drive under a new folder called "GeoBase". This second approach should be utilized only by personnel trained in the use of ArcMap. Should the CEV flight feel that having a GIS analyst on staff is warranted, then the use of ArcINFO would not only have the capability of editing geodatabases and other vector files but would also solve the issue of updating the current Natural Resources layers. This position would also naturally augment the mission of the GeoBase staff and would also greatly enhance other GIS requirements within the Environmental Flight.

10.11.2.2 Data Integration and Access

Integrating the natural resources GeoBase to other databases on base is needed. It has been identified that other data systems such as IRPIMS, ACES, etc., are database systems that are not integrated nor linked to GeoBase. It is fundamentally important that all data or data systems be shared and accessible to GeoBase thereby allowing the natural resources manager to perform a comprehensive analysis with all available data.

The natural resources GeoBase resides in the Installation Restoration Program Information Management System (IRPIMS) GeoBase. While these two databases are complementary, they are not currently integrated from a fully relational database perspective. A very detailed and comprehensive data model has been developed for the IRPIMS GeoBase. This data model allows all relevant IRPIMS data to be stored and accessed very efficiently within a relational database. The INRMP GeoBase data layers should be modeled into

the IRPIMS relational model to facilitate data sharing. For example, the natural resources manager will want to know where the contaminated sites are located just as restoration managers will want to know where wetlands are located relative to their areas of concern and so on.

Coordination for a basewide infrastructure plan for spatial data should be developed. The plan should address contractor data format, and a standard for database modeling. The plan should come first, and implementation should be a cooperative venture among the end-users of basewide spatial data.

10.11.2.3 New Aerial Photography and Photogrammetry

Aerial imagery is available for Hickam AFB (dated 2003), Bellows AFS (dated 2006), Kipapa and Waikakalaua FSAs (dated 2001), and Kaala AFS (dated 2001). However, imagery is not available for Kokee AFS. Kokee AFS is a site that will require aerial photogrammetry once funding is available. In addition, the GeoBase section has plans for an imagery refresh in partnership with other organizations that border Hickam AFB (Pearl Harbor and Honolulu International Airport).

Anytime aerial photography is to be used for mapping purposes, it must be corrected to account for distortion caused by the altitude of the aircraft, curvature of the earth, and spherical nature of the camera's lens. The best method of correcting air photos and accurately registering them to the terrain is analytical aero-triangulation and subsequent stereo compiling. Uncorrected air photos should never be viewed as an accurate source for delineation or placement of features within the GeoBase. A certified photogrammetrist with proper equipment can either use stereo plotting devices to delineate features directly into a digital CADD file, or he/she can produce an "orthophotograph" which can be used for direct delineation of features.

New aerial photography will be necessary to update or "photo-refresh" those data layers that are subject to change over months or several years. Land use/land cover can change significantly over short periods of time. The most efficient and cost-effective method of performing these photo-revisions will be to acquire a single medium-altitude spot shot every year in the same month that the imagery was shot on (to match the one that was used for the original mapping). The photo may be scanned and horizontally rectified (by a certified mapping scientist or photogrammetrist) by matching visible features or tics in the image to known ground features such as surveyed ground panels or landmarks. This process will "warp" the digital image taken of the photograph. The software used to perform this transformation, known as an "affine," should be capable of reporting the residual errors (rms error) associated with the transformation. Once the air photo is registered to the existing data layers, it can be displayed as a back drop to any data layer or used to digitize new data layers.

Some differences will be readily apparent between the land use and vegetation cover areas as displayed in older data layers and the new underlying photo. The photo should be used to photo-refresh or update the older polygons. A copy of the old data layer should be preserved so that after several photo-revisions, a time-series analysis can be performed. Time series analysis can measure change over time and help decision-makers and scientists quantify the loss of one type of land use vs. proliferation of another, changes in

vegetation, and erosion problems. Again, a horizontally rectified image is not an orthophoto, but for mapping natural resources it may be an adequate and more cost effective alternative.

If greater spatial accuracy is required because the photo will be used to delineate jurisdictional boundaries or place physical features, an orthophotograph should be made. Existing photo identification points and digital elevation models can be used to duplicate as closely as possible the process used to create the first set of orthos for Hickam AFB and Bellows AFS.

There is no better source of data for mapping subaerial features than large-scale aerial photography. Photogrammetric mapping is highly accurate and cost-effective. Existing hard-copy maps, drawings, and uncorrected aerial photographs should be carefully scrutinized before being used as sources for digital mapping. Similarly, data provided by contractors should be accompanied by a report of all data sources.

Scheduling of aerial photography should be coordinated among CADD and GeoBase Administrators/Managers and the base comprehensive planner and based on the data layer maintenance plans.

10.11.2.4 Dynamic Update of Natural Resource Data Layers

The digital maps in GeoBase are referred to here as the natural resource layers. Each represents a snapshot of the phenomenon being mapped. Some phenomena such as geology and soils do not change dramatically over the period of several years or even decades. Other phenomena (such as land use and vegetation cover) can change very rapidly and require frequent updates. Therefore, it is difficult to implement a single approach to updating the geodatabase layers. Each data layer will require its own maintenance plan. Each maintenance plan will require different techniques such as photo-revision and ground-level reconnaissance mapping.

Another reason to perform updates is if ancillary data are updated (e.g., , when the NWI wetlands maps are updated by USFWS or flood hazard maps are revised by FEMA) or data (e.g., aerial photos and other spatial data) on adjoining properties (such as MCBH's MCTAB property) become available through cooperative data sharing agreements.

These data should be incorporated on an as-available basis. Often, ancillary data sets like NWI wetlands can be obtained in digital form and loaded into the system without a great deal of effort. Where only hard copy ancillary data updates are available, the manuscripts must be digitized in GeoBase. This may be done in-house or by a qualified mapping consultant.

Updates should not be performed on an ad hoc or continual basis but rather in a structured and deliberate fashion. For example, the vegetation cover and turf management maps might be updated annually (or semi-annually) based on photo-revision with the prerequisite being annual acquisition of new aerial photos for various installations. There are other methods for tracking changes in the spatial distribution of vegetation and grass types, but none may be as cost-effective as photorevision. Each data layer should be evaluated, and a maintenance plan should be devised and subsequently adhered to.

10.11.2.5 Additional Natural Resource Layers and Applications

There are other important data layers that should be developed for the natural resources management GeoBase to facilitate analysis. Such layers include physiographic features (slope, aspect, and drainage basin delineations) that can be derived from existing topographic data. The natural resource GeoBase administrator should coordinate with other agency administrators on the base to ensure that duplication of effort is avoided. For example, certain natural resource information may be developed under the IRPIMS program for use in ecological risk assessment associated with IRP work. Regardless of which group has funded such work, all groups should be notified that it is being done.

Physiographic data layers can be easily produced from the topographic contour maps provided in the INRMP data set. Accurate topographic data is a rich source of raw data from which many other maps can be made. Three-dimensional modeling software such as ESRI's ArcScene and future versions of ArcMap/ArcInfo can be used to create maps showing areas of homogeneous slope or aspect. Slope and aspect are important in performing spatial analysis. These layers may be used to more effectively create buffers around sensitive habitat areas that are being restored or monitored. Gridded topographic data can be used as input to various stormwater runoff, ground water, or soil-loss models. This can be particularly useful in the area of watershed assessment because surficial flow pathways can be automatically drawn from any point on the base. If a building site is proposed, a logical location for stormwater retention can be easily found. This will aid the mitigation for proposed facility projects and is useful to both the engineering staff and the natural resources management staff.

Digital elevation model data derived from existing topographic contours can be used to map topographic depressions prone to inundation. Without elaborate hydrological modeling, a simple map like this can show areas that will be under water assuming overbank discharge or tidal storm surge of a given magnitude. More detailed studies can, of course, benefit from the existing topographic data.

Road centerlines are not usually associated with natural resources, but having them can be very helpful. Currently, the transportation geodatabase has road centerlines where road buffers may be created. The transportation layer is a valuable augmentation to the INRMP data set. For example, if rules for locating new active recreation sites state that no site can be within 50 feet of a secondary road, a spatial query in the geodatabase could be utilized. If a layer of a road buffer zone was created it could be overlaid with the base map for use in site location analysis. In addition, the current transportation layers available from 15 CES are geodatabase layers with topology. Topology refers to spatial relationships among features and serves as a key to functionality. Examples include the relationships between a boundary line and the centroid label that it contains. In area data layers, topology stipulates that boundaries of homogeneous areas must have geometrical closure.

Table 11-2 Priority Project Listing

Priority Number	Project Name	Fiscal Year Funding and Level
1	Incidental Take Permits	FY 08/ACES-PM 1
2	Monitoring Surveys	
3	Section 404 Permit – Training in Wetlands	
4	Mangrove Removal	
5	Ahua Reef Cleanup	
6	Permanent Wetland Database	
7	Tree City USA Designation	
8	GeoBase Accessibility	
9	Watercourse Sediment Removal Feasibility	
10	Control of Invasive Plant Species	
11	Urban Tree Inventory	
12	Integration with Other Databases and CADD	
13	Recreation and Environmental Education Needs Assessment	
14	Shoreline Access/Interpretive Trails	
15	Trail Impact Monitoring and Maintenance	
16	Harbor Park Enhancement	
17	New Aerial Photography and Photogrammetry	
18	Maintain/Update Natural Resource Data Layers	
19	Long-Term Monitoring of Wetland Functions	
20	Watershed Assessment	
21	Exotic Predator Control	
22	Landscape Development Master Plan	
23	Urban Forestry Management Plan	
24	Wetlands Restoration at Bellows AFS Oxbow	
25	High-value Wetland Reserve Area Restoration	
26	Wetland Enhancement at Fort Kamehameha	
27	Riparian Enhancement	
28	Exotic fish Eradication	
29	Natural Resources Web Page	
30	Boat Best Management Practices	
31	Outleasing for Native Plant Horticulture	
32	Woody Fuel and Flammable Vegetation Survey and Removal	
33	Reorganization/Training for Grounds Shop	
34	Bird Watching Guide	
35	Revegetation: Ammunition Storage/Training Area	
36	Urban Tree and Plant Seed Harvest	
37	Black-necked Stilt Radiotracking	
38	Self-Guided Horticultural Interpretive Tour	
39	Additional Natural Resource GeoBase Layers	

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* Recommended addition to 15 AW environmental planning library.

APPENDIX A

ABBREVIATIONS ACRONYMS AND TERM DEFINITIONS

ABBREVIATIONS AND ACRONYMS

15 ABW	15th Air Base Wing
15 AW	15th Airlift Wing
15 CES	15th Civil Engineer Squadron
15 CES/CEVP	15th Civil Engineer Squadron, Environmental Planning Element
15 CES/CEVR	15th Civil Engineer Squadron, Environmental Restoration Program
30 RANS	30 Range Squadron
AAF	Army Airfield
AAFES	Army Air Force Exchange Service
ADC	Animal Damage Control
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
AFI	Air Force Instruction
AFPD	Air Force Policy Directive
AFS	Air Force Station
AFSCN	Air Force Satellite Control Network
AMC	Air Mobility Command
AOC	Areas of Concern
APHIS	Animal & Plant Health Inspection Service
ARAB	Applicable or Relevant and Appropriate Requirements
AVGAS	Aviation Gas
AWACS	Airborne Warning and Control Systems
BASH	Bird-Aircraft Strike Hazard
BCP	Base Comprehensive Plan
BEEF	Base Engineering Emergency Force
BMP	Best Management Practice
BR	BASH Reduction
CAI	Coastal America Initiative
CERCLA	Comprehensive Environmental, Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CZMP	Coastal Zone Management Program
DEQPPM	Defense Environmental Quality Program Policy Memorandum
Det 6, 750 SG	Detachment 6, 750th Space Group
DLNR	Department of Land and Natural Resources (Hawaii)
DOA	Department of Agriculture (Hawaii)
DoD	Department of Defense
DoDD	Department of Defense Directive
DOH	Department of Health (Hawaii)
ECAMP	Environmental Compliance and Management Programs
EDMDS	Environmental Data Management Decision Support
ELC	Environmental Leadership Council
EPA	U.S. Environmental Protection Agency

FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
FONPA	Finding of No Practicable Alternative
FONSI	Finding of No Significant Impact
FSA	Fuel Storage Annex
GIS	Geographic Information System
GLDP	General Landscape Development Plan
GPS	Global Positioning System
HIA	Honolulu International Airport
HIANG	Hawaii Air National Guard
HIARNG	Hawaii Army National Guard
HIIR	Hawaii Independent Refinery
HNHP	Hawaii Natural Heritage Program
HQ AFCEE	Headquarters Air Force Center for Environmental Excellence
HQ PACAF	Headquarters Pacific Air Forces
HROCC	Hawaii Region Operations Control Center
INRMP	Integrated Natural Resources Management Plan
IR	Intensive Recreation
IRP	Installation Restoration Program
IRPIMS	Installation Restoration Program Information Management System
IT	Intensive Training
IWDC	Industrial Wastewater Discharge Certificates
JIPAC	Joint Intelligence Command, Pacific
LHM	Landscaped - High Maintenance
LLM	Landscaped - Low Maintenance
MAC	Military Air Command
MAJCOM	Major Command
MAS	Microwave Antenna Site
MATS	Military Air Transport Service
MCBH	Marine Corps Base Hawaii
MCTAB	Marine Corps Training Area Bellows
MEA	Management Emphasis Area
MILCON	Military Construction
MNH	Managed Natural Habitat
MOGAS	Automotive Gas
msl	mean sea level
MWR	Morale Welfare Recreation
NAR	Natural Area Reserve
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NPDES	National Pollution Discharge Elimination System
NRMU	Natural Resource Multiple Use
NWI	National Wetlands Inventory

O&M	Operations and Maintenance
O&S	Operations and Services
OCP	Operational Component Plan
OOP	Office of Planning
PACAF	Pacific Air Forces
PAH	Polynuclear Aromatic Hydrocarbon
POL	Petroleum, Oil, and Lubricant
ppt	parts per thousand
RTE	Rare, Threatened, and Endangered
SOCAL	Standard Oil of California
SOON	Solar Optical Observing Network
SR	State Route
TNC	The Nature Conservancy
UIC	Underground Injection Control
USACOE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USMC	United States Marine Corps
UST	Underground Storage Tank
VHF	Very High Frequency
VOC	Volatile Organic Compound
VP	Valve Pit
WES	Waterways Experiment Station

APPENDIX C

PLANT SPECIES LISTS

Plant Species List – Hickam Air Force Base

The following checklist is an inventory of all the vascular plants observed during the field studies in the unmanaged vegetation on the base. The plants are arranged alphabetically by families into two groups: monocots and dicots. The taxonomy and nomenclature of these flowering plants follow Wagner et al. (1990).

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Federal Status (FS). The following symbols are used:

E	=	Endangered
T	=	Threatened
P	=	Formally proposed as endangered or threatened
C	=	Candidate for listing
R	=	Recommended as endangered, threatened, or candidate
(SOC)	=	Hawaii State Species of Special Concern
CH	=	Critical habitat declared

4. Biogeographic status. The following symbols are used:

I	=	Indigenous. Native to Hawaiian Islands and also elsewhere throughout the Pacific and tropics.
I?	=	Questionably indigenous. Data not clear if dispersal by natural or human-related mechanisms, but weight of evidence suggests probably indigenous.
X	=	Introduced or alien. All those plant species brought to islands by humans, intentionally or accidentally, after Western contact, that is, Cook's discovery of the islands in 1778.
X?	=	Questionably introduced. Dates of introduction unclear or very early.

5. Presence (+) or absence (-) of a particular species within each of five vegetation types recognized in this study. Horticultural species occurring in landscaped areas were not assigned to a vegetation type. The following symbols are used:

R	=	Ruderal Vegetation
B	=	Buffelgrass/Kiawe Association
K	=	Kiawe Forest
P	=	Pickleweed/Kiawe Wetland
M	=	Mangrove Wetland

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APPENDIX C PLANT SPECIES LIST – HICKAM AIR FORCE BASE.

Scientific Name	Common Name	Hawaiian Name	FS	BS	Veg. Type				
					R	B	K	P	M
Flowering Plants									
Monocots									
COMMELINACEAE (Spiderwort Family)									
Commelina benghalensis L.	Hairy honohono			X	-	+	+	-	-
LILIACEAE (Lily Family)									
Aloe vera L.	aloe			X	-	-	-	+	-
POACEAE (Grass Family)									
Bothriochloa pertusa (L.) A. Camus	pitted beardgrass			X	+	-	-	-	-
Cenchrus ciliaris L.	buffelgrass			X	+	+	+	+	-
Chloris barbata (L.) Sw.	swollen fingergrass	mau'u lei		X	+	+	+	+	-
Cynodon dactylon (L.) Pers.	Bermuda grass	manienie		X	+	-	-	-	-
Eragrostis tenella (L.) P. Beauv. ex Roem. & Schult	lovegrass	hakonokono		X	+	-	+	-	-
Leptochloa uninervia (K. Presl) Hitchc. & Chase	leptocloa			X	-	-	-	+	-
Panicum maximum var. *trichoglume* Eyles ex Robyns	green panicgrass			X	-	-	+	-	-
Rhynchelytrum repens (Willd.) Hubb.	Natal redtop grass			X	+	-	-	-	-
Setaria verticillata (L.) P. Beauv.	bristly foxtail			X	-	-	+	+	-
Sporobolus indicus (L.) R. Br.	West Indian dropseed			X	+	-	-	-	-
Sporobolus pyramidatus (Lam.) Hitchc.				X	+	-	-	+	-
Sporobolus virginicus (L.) Kunth	beach dropseed	'aki'aki		I	-	-	-	-	+
Sporobolus sp.				X	-	-	-	+	-
Dicots									
ACANTHACEAE (Acanthus Family)									
Asystasia gangetica (L.) T. Anderson	Chinese violet, asystasia			X	-	-	+	-	-
AIZOACEAE (Fir-marigold Family)									
Sesuvium portulacastrum (L.) L.	sea purslane	'akiulikuli		I	-	-	-	+	+
ASCLEPIADACEAE (Milkweed Family									
Stapelia gigantea N. E. Brown	carrion flower			X	-	-	+	-	-
ASTERACEAE (Daisy Family)									
Bidens alba (L.) DC.	beggartick			X	+	-	-	-	-
Bidens alba var. radiata (Schultz-Bip.) Ballard ex Melcher	white-flowered bidens			X	+	-	-	-	-

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APPENDIX C PLANT SPECIES LIST – HICKAM AIR FORCE BASE (continued).

Scientific Name	Common Name	Hawaiian Name	FS	BS	Veg. Type				
					R	B	K	P	M
Bidens pilosa L.	Spanish Needle	ki, ki nehe		X	+	-	+	-	-
Flaveria trinervia (Spreng.) C. Mohr.	flaveria			X	+	-	-	-	-
Pluchea X fosbergli Cooperr. and Galang	hybrid pluchea			X	+	-	-	-	+
Pluchea indica (L.) Less.	Indian pluchea, Indian fleabane			X	+	+	+	+	+
Pluchea symphytifolia (Mill.) Gillis	pluchea, sourbrush			X	+	+	+	-	-
Sonchus oleraccus L.	sowthistle	pualele		X	+	-	+	+	-
Tridax procumbens L.	coatbuttons			X	+	-	-	-	-
Verbesina encelioides (Cav.) Benth. & Hook.	golden crown-beard			X	+	-	+	-	-
BATIDACEAE (Saltwort Family)									
Batis maritima L.	pickleweed	'akulikuli kai		X	-	-	-	+	+
BORAGINACEAE (Borage Family)									
Heliotropium procumbens var. *depressum* (Cham.) Fosb.				X	+	-	-	-	-
CARYOPHYLLACEAE (Pink Family)									
Spergularia marina (L.) Griseb.	saltmarsh sand spurry			X	-	-	-	+	-
CASUARINACEAE (Ironwood Family)									
Casuarina equisetifolia L.	common ironwood	paina		X	-	-	+	-	-
CHENOPODIACEAE (Goosefoot Family)									
Atriplex semibaccata R. Br.	Australian saltbrush			X	+	-	-	+	-
Atriplex suberecta Verd.	saltbrush			X	-	-	+	-	-
Chenopodium murale L.	nettle-leaved goosefoot	'aheahea		X	-	-	+	+	-
CONVOLVULACEAE (Morning-glory Family)									
Merremia aegyptia (L.) Urb.	hairy merremia	koali kua hulu		X?	-	-	+	-	-
EUPHORBIACEAE (Spurge Family)									
Chamaesyce hirta (L.) Millsp.	hairy spurge, garden spurge			X	+	+	-	-	-
Chamaesyce hypericifolia (L.) Millsp.	graceful spurge			X	+	+	-	-	-
FABACEAE (Pea Family)									
Alysicarpus vaginalis (L.) DC.	alysicarpus			X	+	-	-	-	-
Desmanthus virgatus (L.) Willd.	slender mimosa			X	+	-	+	-	-
Desmodium tortuosum (Sw.) DC.	Florida beggarweed			X	+	-	-	-	-
Indigofera spicata Forssk.	creeping indigo			X	+	-	-	-	-

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APPENDIX C PLANT SPECIES LIST – HICKAM AIR FORCE BASE (continued).

Scientific Name	Common Name	Hawaiian Name	FS	BS	Veg. Type				
					R	B	K	P	M
Leucaena leucocephala (Lam.) de Wit		koa-haole, ekoa		X	+	+	+	-	-
Pithecellobium dulce (Roxb.) Benth.	Manila tamirind, Madras thorn	'opiuma		X	+	+	+	-	-
Prosopis pallada (Humb. & Bonpl. ex Willd.) Kunth	algaroba, mesquite	kiawe		X	+	+	+	+	-
MALVACEAE (Mallow family)									
Malvastrum coromandelianum (L.) Garcke	false mallow	hauuoi		X	+	+	-	-	-
Sida rhombifolia L.	Cuba jute			X	+	-	-	-	-
Thespesia populnea (L.) Sol. ex Correa		milo		I?	-	-	+	-	+
NYCTAGINACEAE (Four-o'clock Family)									
Boerhavia coccinea Mill.	red-flowered boerhavia	alena		X	+	-	-	-	-
PASSIFLORACEAE (Passion Flower Family)									
Passiflora foetida L.	scarlet-fruited passion flower	pohapoha		X	+	-	-	-	-
RHIZOPHORACEAE (Mangrove Family)									
Rhizophora mangle L.	American mangrove, red mangrove			X	-	-	-	-	+
SOLANACEAE (Tomato Family)									
Nicotiana glauca R.C. Graham	tree tabacco			X	+	-	-	-	-
STERCULIACEAE (Cacao Family)									
Waltheria indica L.		'uhaloa, hi'aloa, kanakaloa		I?	+	+	-	-	-
TAMARICACEAE (Tamarix Family)									
Tamarix apylla (L.) Karst.	tamarisk, Athel tamarisk			X	-	-	-	+	-
VERBENACEAE (Verbena Family)									
Verbena litoralis Kunth	weed verbena	oi		X	+	-	-	-	-

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APPENDIX D

FISH AND WILDLIFE SPECIES LISTS

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	Shallenberger 1977	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
HICKAM AFB																			
Mammals																			
Herpestes auropunctatus	mongoose			X	X														
Rattus rattus	black rat			X	X										X				
Rattus exulans	Polynesian rat														X				
Felis domesticus	cat			X	X										X				
Peromyscus sp.	mouse			X	X														
Lasiurus cinereus semotus	Hawaiian hoary bat	ope'ape'a	E		X														
Monachus schauinslandi	Hawaiian monk seal	'ilio-holo-i-ka-uaua	E		X														
Megaptera novaeangliae	humpback whale	kahola	E		X														
Birds																			
Sula leucogaster plotus	brown booby	'a		X	X														
Fulica americana alai	Hawaiian coot	'alae ke'oke'o	E		X														
Gallinula chloropus sandwichensis	common moorhen	'alae 'ula	E		X														
Tyto alba	barn owl				X														
Asio flammeus sandwichensis	Hawaiian short-eared owl	pueo	(SOC)		X														

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APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	*Shallenberger 1977*	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Anas wyvilliana	Hawaiian duck	koloa maoli	E		X														
Columba livia	rock dove													X					
Amazone ochrocephala	yellow-headed Amazon parrot														X				
Pluvialis fulva	Pacific golden-plover	kolea		X	X														
Heteroscelus incanus	wandering tattler	'ulili		X	X														
Arenaria interpres	ruddy turnstone	'akekeke		X	X														
Calidris alba	sanderling	hunakai		X	X														
Himantopus mexicanus knudensi	black-necked stilt	ae'o	E	X	X														
Nycticorax nycticorax hoactli	black-crowned night heron-	'auku'u		X	X														
Bubulcus ibis	cattle egret			X	X														
Streptopelia chinensis	spotted dove			X	X														
Geopelia striata	zebra dove			X	X														
Acridotheres tristis	common myna			X	X														
Mimus polyglottus	northern mockingbird			X	X														
Cardinalis cardinalis	northern cardinal			X	X									X					
Paroaria coronata	red-crested cardinal			X	X														

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APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information: Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	Shallenberger 1977	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Pycnonotus cafer	red-vented bulbul			X	X														
Copsychus malabaricus	white-rumped shama			X	X														
Cettia diphone	Japanese bush-warbler			X	X														
Zosterops japonicus	Japanese white-eye			X	X														
Padda oryzivora	java sparrow			X	X														
Carpodacus mexicanus	house finch			X	X														
Passer domesticus	house sparrow			X	X														
Estrilda astrild	common waxbill			X	X														
Lonchura punctulata	nutmeg mannikin			X	X														
Sicalis flaveola	saffron finch			X	X														
Reptiles																			
Chelonia mydas	green sea turtle	honu	T	X	X														
Amphibians																			
Rana sp.	frog			X	X														
Fish																			
Sphyrna lewini	scalloped hammerhead shark	mano-kihikihi		X														X	X
Carcharhinus melanopterus	blacktip reef shark	mano pa'ele		X														X	X

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APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	*Shallenberger 1977*	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Carcharhinus plumbeus	sandbar shark	mano		X															
Galeocerdo cuvier	tiger shark	niuhi		X															
Triaenodon obesus	whitetip reef shark	mano-lala-kea		X															
Carcharhinus limbatus	Oceanic blacktip shark	mano		X															
Carcharhinus galapagensis	Galapagos shark	mano		X															
Belonidae (2 species)	needlefish	aha aha		X														X	X
Selar crumenophthalmus	bigeye scad, aji	akule (halalu)																X	X
Chanos chanos	milkfish	awa																X	X
Heteropriacanthus cruentatus	bigeye	aweoweo																X	X
Dasyatis brevis	Hawaiian stingray	hihimanu		X															
Dasyatidae (2 species)	stingray	hihimanu																X	X
Aetobatus narinari	spotted eagle ray	hailepo		X															
Sphyraena barracuda	great barracuda	kaku		X	X													X	X
Sphyraena helleri	Japanese barracuda	kawelea																X	X
Scomberoides lysan	leatherback	lae		X	X													X	X
Xyrichtys pavo	peacock razorfish	laenihi																X	X
Monotaxis grandoculis	bigeye emperor	mu		X	X													X	X

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APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	Shallenberger 1977	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Kyphosus spp.	chub	nenue																X	X
Lutjanus kasmira	blue-stripe snapper	ta'ape																X	X
Lutjanus fulvus	blacktail snapper	to'au		X	X													X	X
Aprion virescens	gray snapper	uku																X	X
Aphareus furca	forktail snapper, gorotsuki	wahanui (hanui)																X	X
Caranx melampygus	blue fin trevally, hoshi'	ulua omilu																X	X
Kuhlia sandvicensis	Hawaiian flagtail	'aholehole		X	X														
Mugil cephalus	striped mullet	ama'ama		X	X													X	X
Neomyxus leucisus	false mullet	ououa		X	X														X
Tilapia spp.	tilapia			X	X														X
Bothus pantherinus	panther flounder	paki'i		X	X													X	X
Eleotris sandwichensis		o'opu akupa		X	X														
Stenogobius hawaiiensis		o'opu naniha		X	X														
Apogon kallopterus	iridescent cardinalfish	'upapalu makanui		X	X													X	X
Foa brachygramma	bay cardinalfish	upapalu		X	X														X
Myripristis spp.	soldierfish	u'u																X	X
Gambusia affinis	mosquitofish			X	X														

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APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	*Shallenberger 1977*	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Poecilia sphenops	liberty molly			X	X														
Poecilia vittata	Cuban molly			X	X														
Poecilia velifera	sailfin molly			X	X														
Gnatholepus anjerensis	eye-bar goby			X	X														
Echidna nebulosa	snowflake moray	puhi kapa		X	X													X	X
Gymnothorax meleagris	whitemouth moray	puhi 'oni'o		X	X													X	X
Gymnothorax undulatus	undulated moray	puhi laumilo		X	X													X	X
Synodus binotatus	twospot lizardfish	'ulae		X	X														X
Synodus variegatus	reef lizardfish	'ulae		X	X														X
Sargocentron xantherythrum	Hawaiian squirrelfish	ala'ihi		X	X														X
Aulostomus chinensis	trumpetfish	nunu		X	X													X	X
Fistularia commersonii	cornetfish	nunu peke		X	X													X	X
Doryrhamphus excisus	bluestripe pipefish			X	X														X
Scorpaenopsis diabolus	devil scorpionfish	nohu 'omakaha		X	X														X
Mulloidichthys flavolineatus	yellowstripe goatfish	weke'a		X	X													X	X
Mulloidichthys vanicolensis	yellowfin goatfish	weke 'ula		X	X													X	X
Parupeneus pleurostigma	sidespot goatfish	malu																X	X

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APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	*Shallenberger 1977*	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Parupeneus cyclostomus	blue goatfish	moano kea		X	X													X	X
Parupeneus bifasciatus	doublebar goatfish	munu																X	X
Parupeneus multifasciatus	manybar goatfish	moano		X	X													X	X
Parupeneus porphyreus	whitesaddle goatfish	kumu		X	X													X	X
Upeneus taeniopterus	bandtail goatfish	weke pue'o																X	X
Chaetodon auriga	threadfin butterflyfish	kihikihi		X	X														X
Chaetodon lunula	racoon butterflyfish	kikakapu		X	X														X
Chaetodon miliaris	milletseed butterflyfish	lauwiliwili		X	X														X
Chaetodon multicinctus	multiband butterflyfish	kikakapu		X	X														X
Chaetodon ornatissimus	ornate butterfly	kikakapu kahuhili		X	X														X
Chaetodon quadrimaculatus	fourspot butterflyfish	lauhau		X	X														X
Chaetodon unimaculatus	teardrop butterflyfish	lauhau		X	X														X
Forcipiger flavissimus	long-nose butterflyfish	lauwiliwilinukunukuoi oi'		X	X														X
Cirrhitops fasciatus	redbar hawkfish	pilikoa		X	X														X
Cirrhitus pinnulatus	stocky hawkfish	po'apa'a		X	X													X	X
Paracirrhites arcatus	arc-eye hawkfish	pilikoa		X	X														X
Paracirrhites forsteri	blackside hawkfish	hilu pilikoa		X	X														X

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APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

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				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	*Shallenberger 1977*	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Abudefduf abdominalis	Hawaiian sergeant	mamo		X	X													X	X
Abudefduf sordidus	blackspot sergeant	kupipi																X	X
Chromis agilis	agile chromis			X	X														X
Chromis hanui	chocolatedip chromis			X	X														X
Chromis ovalis	oval chromis			X	X														X
Chromis vanderbilti	blackfin chromis			X	X														X
Dascyllus albisella	Hawaiian dascyllus	'alo'ilo'i		X	X														X
Plectroglyphidodon imparipennis	brighteye damselfish			X	X														X
Plectroglyphidodon johnstonianus	blueeye damselfish			X	X														X
Anampses cuvier	pearl wrasse	opulepule lauli		X	X														X
Bodianus bilunulatus	Hawaiian hogfish	a'awa		X	X													X	X
Coris gaimard	yellowtail coris	hinalea 'akilolo		X	X														X
Cheilinus unitusciatus	ringtail wrasse	po'ou																X	X
Cephalopholis argus	peacock grouper, roi																	X	X
Gomphosus varius	bird wrasse	akilolo		X	X														X
Halichoeres ornatissimus	ornate wrasse	ohua pa'awela		X	X														X

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APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	Shallenberger 1977	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Labroides phthirophagus	Hawaiian cleaner wrasse	hinalea		X	X														
Novaculichthys taeniourus	rockmover			X	X														X
Pseudocheilinus octotaenia	eightline wrasse	ale'ihi lakea		X	X														X
Stethojulis balteata	belted wrasse	'omaka		X	X														X
Cheilio inermis	mongoose wrasse, cigar wrasse	kupoupou																X	X
Thalassoma ballieui	blacktail wrasse	hinalea luahine		X	X														X
Thalassoma duperrey	saddle wrasse	hinalea lauwili		X	X														X
Thalassoma trilobatum	Christmas wrasse	'awela		X	X														X
Calotomus carolinus	stareye parrotfish	ponuhunuhu		X	X														X
Scarus perspicillatus	spectacled parrotfish	uhu uliuli		X	X														X
Scarus psittacus	palenose parrotfish	uhu		X	X														X
Scarus rubroviolaceus	redlip parrotfish	palukaluka		X	X														X
Scarus sordidus	bullethead parrotfish	uhu		X	X														X
Plagiotremus goslinei	scale eating blenny			X	X														X
Zanclus comutus	moorish idol	kihikihi		X	X													X	X
Acanthurus dussumieri	eyestripe surgeonfish	palani		X	X													X	X
Acanthurus leucopareius	whitebar surgeonfish	maikoiko		X	X													X	X

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APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information														
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Acanthurus nigrofuscus	brown surgeonfish	mai'i'i		X	X													X	X
Acanthurus nigroris	blueline surgeonfish	maiko		X	X													X	X
Acanthurus olivaceus	orangeband surgeonfish	na'e na'e																X	X
Acanthurus triostegus	convict tang	manini		X	X													X	X
Acanthurus xanthopterus	yellowfin surgeonfish	pualu		X	X														X
Ctenochaetus strigosus	gold-ring surgeonfish	kole		X	X													X	X
Naso lituratus	orangespine unicornfish	umaumalei		X	X														X
Naso unicornis	bluespine unicornfish	kala		X	X													X	X
Zebrasoma flavescens	yellow tang	lauipala		X	X														X
Zebrasoma veliferum	sailfin tang	mane'one'o		X	X														X
Zebrasoma aculeatus	lagoon triggerfish	humuhumunukunukua' pua'a		X	X														X
Zebrasoma rectangulus	reef triggerfish	humuhumunukunukua' pua'a		X	X														X
Aluterus scriptus	scribbled filefish	loulu																X	X
Cantherhines dumerilii	barred filefish	'o'ili		X	X													X	X
Cantherhines sandwichensis	squaretail filefish	'o'ili lepa		X	X													X	X

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APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	*Shallenberger 1977*	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Pervagor spilosoma	fantail filefish	'o'lii uwi' uwi		X	X													X	X
Ostracion meleagris	spotted trunkfish	moa		X	X														X
Arothron hispidus	stripebelly puffer	'o'opu hue		X	X													X	X
Arothron meleagris	spotted puffer	'o'opu hue		X	X														X
Canthigaster amboinensis	lambon toby	pu'u olai		X	X														X
Canthigaster coronata	crown toby	pu'u olai		X	X														X
Canthigaster jactator	Hawaiian white-spotted toby			X	X														
Diodon holocanthus	spiny puffer	'o'opu okala		X	X														X
Albula sp.	bonefish	o'io		X	X													X	X
Encrasicholina purpureus	anchovy	nehu		X	X													X	X
Elops hawaiiensis	Hawaiian ladyfish	awa'awa		X	X														X
Crustaceans																			
Ocypode spp.	ghost crab	'ohiki		X	X														
Thalamita crenata	blue-pincher crab			X	X														
Portunus sanguinolentus	haole crab			X	X														
Penaeus marginatus	shrimp			X	X														

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APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information: Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	Shallenberger 1977	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Thalamita integra	crab			X	X														
Alpheus sp.	shrimp			X	X														
Grapsus tenuicrustatus	rock crab	a'ama		X	X														
Procambrus clarkii	crayfish			X	X														
Echinoderms																			
Actinopyga mauritiana				X	X														
Echinometra mathaei	rock boring urchin			X	X														
Echinostrephus aciculatus	sea urchin	wana		X	X														
Echinothrix calamaris	black long-spined urchin	wana		X	X														
Echinothrix diadema	sea urchin	wana		X	X														
Heterocentrotus mammillatus	sea urchin	wana		X	X														
Holothuria atra	sea cucumber			X	X														
Ophiodesoma spectabilis				X	X														
Tripneustes gratilla	collector urchin	wana		X	X														
Mollusks																			
Euglandina sp.	African snail			X	X														
Corbicula forbinia	Asiatic clam (shell only)			X	X														

Hickam - 12

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	*Shallenberger 1977*	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Littorina scabra	snail			X	X														
Melanoides sp.	thiarid snail			X	X														
Coelenterates																			
Aurelia aurita	moon jelly				X														
Charybda spp.	box jelly				X														
Physalia physalis	Portuguese man-o-war				X														

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APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information: Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	Shallenberger 1977	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
BELLOWS AFS																			
Mammals																			
Felis domesticus	cat			X		X													
Herpestes auropunctatus	mongoose			X		X													
Rattus sp.	rat			X		X													
Mus sp.	mouse					X													
Lasiurus cinereus semotus	Hawaiian hoary bat	ope'ape'a	E			X													
Monachus shauinslandi	Hawaiian monk seal	'ilio-holo-i-ka-uaua	E														X		
Megaptera novaeangliae	humpback whale	kahola	E			X													
Birds																			
Arenaria interpres	ruddy turnstone	'akekeke		X		X										X	X		
Calidris alba	sanderling	hunakai															X		
Himantopus mexicanus knudseni	black-necked stilt	ae'o	E	X		X										X			
Anas wyvilliana	Hawaiian duck	koloa maoli	E			X										X			
Fulica americana alai	Hawaiian coot	'alae ke'oke'o	E			X													
Gallunula chloropus sandwichensis	common moorhen	'alae 'ula	E			X													

Bellows - 1

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information														
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	Shallenberger 1977	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Puffinus newelli	Newell's shearwater	'a'o	T			X													
Pluvialis fulva	Pacific golden-plover	kolea		X		X										X			
Heteroscelus incanus	wandering tattler	'ulili		X		X										X			
Nycticorax nycticorax hoactli	black-crowned night-heron	'auku'u		X		X										X			
Bubulcus ibis	cattle egret			X		X										X	X		
Streptopelia chinensis	spotted dove					X										X	X		
Geopelia striata	zebra dove			X		X										X	X		
Acridotheres tristis	common myna			X		X										X	X		
Mimus polyglottus	northern mockingbird			X		X										X	X		
Cardinalis cardinalis	northern cardinal			X		X										X	X		
Paroaria coronata	red-crested cardinal			X		X										X	X		
Pycnonotus cafer	red-vented bulbul			X		X											X		
Copsychus malabaricus	white-rumped shama			X		X										X	X		
Cettia diphone	Japanese bush-warbler			X		X											X		
Zosterops japonicus	Japanese white-eye			X		X										X			
Padda oryzivora	java sparrow			X		X										X	X		
Carpodacus mexicanus	house finch			X		X										X	X		

Bellows - 2

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information														
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	Shallenberger 1977	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Passer domesticus	house sparrow			X		X										X	X		
Estrilda astrild	common waxbill			X		X										X	X		
Lonchura punctulata	nutmeg mannikin			X		X										X	X		
Serinus mozambicus	yellow-fronted canary					X										X	X		
Colombia livia	rock dove					X											X		
Alauda arvensis	Eurasian skylark					X											X		
Lonchura malacca	chestnut mannikin					X											X		
Tyto alba	barn owl					X										X			
Asio flammeus sandwichensis	Hawaiian short-eared owl	pueo	(SOC)			X													
Puffinus pacificus	wedge-tailed shearwater	'ua 'u kani														X			
Sula dactylatra	masked booby	'a														X			
Sula sula rubripes	red-footed booby	'a														X			
Sula leucogaster plotus	brown booby	'a														X			
Fregata minor palmerstoni	great frigatebird	'iwa														X			
Phasianus colchicus	ring-necked pheasant															X	X		
Pycnonotus cafer	red-vented bulbul			X		X										X			
Sicalis flaveola	saffron finch															X			

Bellows - 3

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	Shallenberger 1977	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Lonchura malabarica (cantans)	wartbling silverbill															X			
Reptiles																			
Chelonia mydas	green sea turtle	honu	T			X											X		
Eretmochelys imbricata	hawksbill turtle	I'ea	E			X													
Chrysemys scripta elegans	red-eared slider turtle			X		X													
Amphibians																			
Bufo marinus	marine toad			X		X													
Rana sp.	frog			X		X													
Fish																			
Belonidae (2 species)	needlefish	aha aha																X	X
Sphyraena barracuda	great barracuda	kaku																X	X
Sphyraena helleri	Japanese barracuda	kawelea																X	X
Scomberoides lysan	leatherback	lae																X	X
Xyrichtys pavo	peacock razorfish	laenihi																X	X
Polydactylus sexfilis	threadfin	moi																X	X
Bothus spp.	flounder	paki'i																X	X
Cephalopholis argus	peacock grouper, roi																	X	X

Bellows - 4

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	Shallenberger 1977	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Lutjanus kasmira	blue-stripe snapper	ta'ape																X	X
Lutjanus fulvus	blacktail snapper	to'au																X	X
Myripristis spp.	soldierfish	'u'u																X	X
Kuhlia sandvicensis	Hawaiian flagtail	aholehole		X		X													
Tilapia spp.	tilapia			X		X												X	
Neomyxus leucisus	false mullet	ououa		X		X													X
Mugil cephalus	striped mullet	ama'ama		X		X													
Caranx ignoblis	giant trevally	ulua aukea		X		X													X
Poecilia sphenops	liberty molly			X		X													
Xiphophorous helleri	swordtail			X		X													
Poecilia vittata	Cuban molly			X		X													
Gambusia affinis	mosquitofish			X		X													
Awaous guamensis	goby	o'opu nakea		X		X													
Eleotris sandwichensis		o'opu akupa		X		X													
Stenogobius hawaiiensis		o'opu naniha		X		X													
Misgurnus anguillicaudatus	dojo loach			X		X													
Mulloidichthys flavolineatus	yellowstripe goatfish	weke'a		X		X													

Bellows - 5

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	Shallenberger 1977	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Parupeneus pleurostigma	sidespot goatfish	malu																X	X
Parupeneus bifasciatus	doublebar goatfish	munu																X	X
Upeneus taeniopterus	bandtail goatfish	weke pue'o																X	X
Parupeneus cyclostomus	blue goatfish	moano kea		X		X												X	X
Parupeneus multifasciatus	manybar goatfish	moano		X		X												X	X
Chaetodon miliaris	milletseed butterflyfish	lauwiliwili		X		X													X
Chaetodon multicinctus	multiband butterflyfish	kikakapu		X		X													
Forcipiger spp.	long-nose butterflyfish	lauwiliwili		X														X	X
Abudefduf abdominalis	Hawaiian sergeant	mamo		X		X												X	X
Abudefduf sordidus	gray damselfish	kupipi		X		X												X	X
Dascyllus albisella	Hawaiian dascyllus	'alo'ilo'i		X		X													X
Stegastes fasciolatus	Pacific gregory			X		X													X
Plectroglyphidodon johnstonianus	blue-eye damselfish			X		X													X
Anampses cuvier	pearl wrasse	opulepule lauli		X		X												X	X
Cheilio inermis	mongoose wrasse, cigar wrasse	kupoupou																X	X
Cheilinus unitusciatus	ringtail wrasse	po'ou																X	X

Bellows - 6

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	*Shallenberger 1977*	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Gomphosus varius	bird wrasse	akilolo		X		X													X
Labroides phthirophagus	Hawaiian cleaner wrasse	hinalea		X		X													X
Stethojulis balteata	belted wrasse	'omaka		X		X													X
Thalassoma ballieui	blacktail wrasse	hinalea luahine		X		X													X
Thalassoma duperrey	saddle wrasse	hinalea lauwili		X		X													X
Thalassoma trilobatum	Christmas wrasse	'awela		X		X													X
Calotomus carolinus	stareye parrotfish	ponuhunuhu		X		X													X
Scarus psittacus	palenose parrotfish	uhu		X		X													X
Scarus sordidus	bullethead parrotfish	uhu		X		X													X
Zanclus cornutus	moorish idol	kihikihi		X		X												X	X
Acanthurus triostegus	convict tang	manini		X		X												X	X
Acanthurus olivaceus	orangeband surgeonfish	na'e na'e																X	X
Acanthurus nigroris	blueline surgeonfish	maiko																X	X
Acanthurus leucopareius	whitebar surgeonfish	maikoiko		X		X													X
Acanthurus blochii	ringtail surgeonfish	pualu		X		X													X
Acanthurus nigrofuscus	brown surgeonfish	mai'i'i		X		X												X	X
Acanthurus achilles	Achilles tang	paku'iku'i		X		X												X	X

Bellows - 7

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	*Shallenberger 1977*	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Acanthurus dussumieri	eyestripe surgeonfish	palani		X		X												X	X
Acanthurus xanthopterus	yellowfin surgeonfish	pualu		X		X													X
Ctenochaetus strigosus	gold-ring surgeonfish	kole		X		X												X	X
Naso unicornis	bluespine unicornfish	kala		X		X												X	X
Zebrasoma flavescens	yellow tang	lauipala		X		X													X
Arothron hispidus	stripebelly puffer	'o'opu hue		X		X												X	X
Arothron meleagris	spotted puffer	'o'opu hue		X		X													X
Gymnothorax flavimarginatus	yellowmargin moray	puhi kapa		X		X													
Gymnothorax undulatus	undulated moray	puhi laumilo		X		X													
Apogon kallopterus	iridescent cardinalfish	'upapalu makanui		X		X												X	X
Cirripectes vanderbilti	scarface blenny	pao'o		X		X													X
Aluterus scriptus	scribbled filefish	loulu																X	X
Pervagor spilosoma	fantail filefish	'oili uwi' uwi		X		X													X
Ostricion meleagris	spotted trunkfish	moa		X		X													X
Crustaceans																			
Scylla serrata	Samoan crab			X		X													
Thalamita crenata	blue-pincher crab			X		X													

Bellows - 8

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information: Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	Shallenberger 1977	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Macrobrachium grandimanus	prawn	'opae oeha'a		X		X													
Atyoida bisulcata	shrimp	'opae kala'ole		X		X													
Panulirus marginatus				X		X													
Echinoderms																			
Holothuria atra	sea cucumber			X		X							X						
Holothuria nobilis	sea cucumber			X		X							X						
Diadema paucispinum	sea urchin	wana		X		X													
Echinometra mathaei	rock boring urchin	wana		X		X													
Echinostrephus aciculatus	sea urchin	wana		X		X													
Echinothrix calamaris	black long-spined urchin	wana		X		X													
Echinothrix diadema	sea urchin	wana		X		X							X						
Heterocentrotus mammillatus	sea urchin	wana		X		X													
Tripneustes gratilla	collector urchin	wana		X		X													
Linckia multifora	starfish			X		X													
Linckia diplax	starfish			X		X													
Mollusks																			
Euglandia sp.	African snail			X		X													

Bellows - 9

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information: Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	Shallenberger 1977	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
f. Ampularidae	apple snail			X		X													
Melanoides sp.	thiarid snail			X		X													
Coelenterates																			
Aurelia aurita	moon jelly					X													
Charybda spp.	box jelly					X													
Physalia physalis	Portuguese man-o-war					X													

Bellows - 10

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information: Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	*Shallenberger 1977*	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
KIPAPA FSA																			
Mammals																			
Herpestes auropunctatus	mongoose						X								X				
Rattus rattus	black rat						X								X				
Rattus norvegicus	Norway rat														X				
Rattus exulans	Polynesian rat														X				
Mus musculus	house mouse						X								X				
Canis familiaris	dog						X								X				
Sus scrofa	pig														X				
Felis domesticus	cat														X				
Lasiurus cinereus semotus	Hawaiian hoary bat	ope'ape'a	E				X												
Birds																			
Nycticorax nycticorax hoactli	black-crowned night-heron	'auku'u					X								X				
Heteroscelus incanus	wandering tattler	'ulili					X								X				
Anas wyvilliana	Hawaiian duck	koloa maoli	E				X												
Lonchura punctulata	nutmeg mannikin														X				
Mimus polyglottos	mockingbird														X				

Kipapa - 1

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information														
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	Shallenberger 1977	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Columba livia	rock dove														X				
Tyto alba	barn owl														X				
Pluvialis fulva	Pacific golden-plover	kolea		X			X								X				
Bubulcus ibis	cattle egret			X			X								X				
Streptopelia chinensis	spotted dove			X			X								X				
Geopelia striata	zebra dove			X			X								X				
Acridotheres tristis	common myna			X			X								X				
Cardinalis cardinalis	northern cardinal			X			X								X				
Paroaria coronata	red-crested cardinal			X			X								X				
Pycnonotus cafer	red-vented bulbul			X			X								X				
Copsychus malabaricus	white-rumped shama			X			X								X				
Cettia diphone	Japanese bush-warbler			X			X								X				
Zosterops japonicus	Japanese white-eye			X			X								X				
Carpodacus mexicanus	house finch			X			X								X				
Amphibians																			
Rana catesbiana	bull frog														X				
Rana sp.	frog			X			X												

Kipapa - 2

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	*Shallenberger 1977*	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Fish																			
Gambusia affinis	mosquitofish			X			X												
Poecilia reticulata	guppy			X			X												
Xiphophorous helleri	swordtail			X			X												
Misgurnus anguillicaudatus	dojo loach			X			X												
Crustaceans																			
Atyoida bisculata	shrimp	'opae kala'ole		X			X												
Mollusks																			
Euglandia sp.	African snail														X				
Melanoides sp.	thiarid snail			X			X												

Kipapa - 3

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information: Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	Shallenberger 1977	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
WAIKAKALAUA FSA																			
Mammals																			
Herpestes auropunctatus	*mongoose*						X								X				
Rattus rattus	*black rat*						X								X				
Rattus norvegicus	*Norway rat*														X				
Rattus exulans	*Polynesian rat*														X				
Mus musculus	*house mouse*						X								X				
Canis familiaris	*dog*						X								X				
Sus scrofa	*pig*														X				
Felis domesticus	*cat*														X				
Lasiurus cinereus semotus	Hawaiian hoary bat	ope'ape'a	E				X												
Birds																			
Pluvialis fulva	Pacific golden-plover	kolea		X			X								X				
Streptopelia chinensis	spotted dove			X			X								X				
Geopelia striata	zebra dove			X			X												
Acridotheres tristis	common myna			X			X								X				

Waikakalaua - 1

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	*Shallenberger 1977*	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Cardinalis cardinalis	northern cardinal			X			X								X				
Pycnonotus cafer	red-vented bulbul			X			X								X				
Copsychus malabaricus	white-rumped shama			X			X								X				
Cettia diphone	Japanese bush-warbler			X			X								X				
Zosterops japonicus	Japanese white-eye			X			X								X				
Carpodacus mexicanus	house finch			X			X								X				
Estrilda astrild	common waxbill																		
Amandava amandava	red avadavat																		

Waikakalaua-2

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information: Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	*Shallenberger 1977*	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
KAALA AFS																			
Mammals																			
Canis familiaris	dog			X				X											
Rattus sp.	rat			X				X											
Sus scrofa	pig							X											
Lasiurus cinereus semotus	Hawaiian hoary bat	ope'ape'a	E					X											
Birds																			
Pluvialis fulva	Pacific golden-plover	kolea		X				X											
Zosterops japonicus	Japanese white-eye			X				X					X						
Cettia diphone	Japanese bush-warbler			X				X											
Chasiempis sandwichensis gayi	O'ahu 'elepaio		E										X						
Copsychus malabaricus	white-rumped shama												X						
Garrulax canorus	hwamei												X						
Pycnonotus cafer	red-vented bulbul												X						
Himatione sanguinea		'apapane						X					X						
Hemignathus virens	common 'amakihi	'amakihi						X					X						
Vestiaria coccinea		'i'iwi						X					X						

Kaala - 1

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information														
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	*Shallenberger 1977*	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Asio flammeus sandwichensis	Hawaiian short-eared owl	pueo	(SOC)					X											
Paroreomyza maculata	Oahu creeper	O'ahu 'alauahio	E										X						
Phaethon lepturus	white-tailed tropicbird	koa'e kea											X						
Mollusks																			
Auriculella ambusta	land snail							X					X						
Auriculella tenella	land snail							X					X						
Auriculella new sp. aff. castanea	land snail												X						
Euglandina rosea	predatory land snail												X						
Succinea sp.	land snail							X											
Philonesia sp.	land snail							X											
Tornarellinid sp.	land snail							X											

Kaala - 2

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information: Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	*Shallenberger 1977*	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
KOKEE AFS & KOKEE MAS																			
Mammals																			
Lasiurus cinereus semotus	Hawaiian hoary bat	ope'ape'a	E	X						X									
Rattus norvegicus	Norway rat			X						X									
Felis domesticus	cat									X									
Canis familiaris	dog									X									
Sus scrofa	pig			X						X									
Sylvilagus spp.	rabbit									X									
Birds																			
Vestiaria coccinea		'i'iwi								X									
Asio flammeus sandwichensis	Hawaiian short-eared owl	pueo	(SOC)							X									
Puffinus newelli	Newell's shearwater	'a'o	T							X									
Pterodroma phaeopygia sandwichensis	dark-rumped petrel	'ua'u	E							X									
Pluvialis fulva	Pacific golden-plover	kolea		X						X									
Himatione sanguinea		'apapane		X						X									
Hemignathus virens	common 'amakihi	'amakihi								X									

Kokee - 1

APPENDIX D FISH AND WILDLIFE SPECIES OBSERVED OR POTENTIALLY OCCURRING ON AND OFFSHORE AT 15 AW INSTALLATIONS, HAWAII.

Scientific Name	Common Name	Hawaiian Name	Federal Status	Source of Information															
				Species Observed	EA 1996a	EA 1996b	EA 1996c	EA 1996d	EA 1996e	EA 1996f	EA 1996g	Higginbotham 1993	DLNR 1990	U.S. Air Force 1979	*Shallenberger 1977*	Cribbs 1994	Bruner 1994	DLNR 1982	Hoover 1993
Hemignathus parvus		'anianiau		X						X									
Chasiempis sandwichensis		'elepaio								X									
Gallus gallus	red junglefowl	moa		X						X									
Geopelia striata	zebra dove			X						X									
Acridotheres tristis	common myna			X						X									
Cardinalis cardinalis	northern cardinal			X						X									
Paroaria coronata	red-crested cardinal			X						X									
Copsychus malabaricus	white-rumped shama			X						X									
Garrulax canorus	hwamei			X						X									
Zosterops japonicus	Japanese white-eye			X						X									
Carpodacus mexicanus	house finch			X						X									
Nesochen sandvicensis	Hawaiian goose	nene	E	X															

Kokee - 2

REFERENCES

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EA (Engineering, Science, and Technology). 1996a. Resource Inventory Report for Hickam Air Force Base. Oahu, Hawaii.

EA (Engineering, Science, and Technology). 1996b. Resource Inventory Report for Bellows Air Force Station. Oahu, Hawaii. (With observations by Marine Research Consultants)

EA (Engineering, Science, and Technology). 1996c. Resource Inventory Report for Hickam POL Pipeline Fuel Storage Annexes at Waikakalaua and Kipapa. Oahu, Hawaii.

EA (Engineering, Science, and Technology). 1996d. Resource Inventory Report for Kaala Air Force Station. Oahu, Hawaii.

EA (Engineering, Science, and Technology). 1996f. Resource Inventory Report for Kokee Air Force Station. Kauai, Hawaii.

oover, J.P. Hawaii's Fishes. A Guide for Snorkelers, Divers, and Aquarists. Mutual Publishing, Honolulu, Hawaii.

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Shallenberger, R.J. 1977. Bird and Mammal Survey of Army lands in Hawaii. Ahuimanu Productions. April.

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USFWS (U.S. Fish and Wildlife Service). 1996 Hawaiian Islands Animals: Updated March 1, 1996. Listed and Candidate Species, Designated by the U.S. Endangered Species Act.

Prepared by EA Engineering, Science, and Technology.

Notes: Federal Status: E = Endangered; T = Threatened; C = Candidate for Listing; (SOC) = Hawaii State Species of Concern.
Source: USFWS Threatened and Endangered Species System (TESS), 2007.

A "Species Observed" means the species was observed during field trips in 1996 by EA and/or its subcontractors. Marine species observed in Waimanalo Bay by Marine Research Consultants during 1994 were also included. Also, a nene observation occurred at Kokee AFS during a 1997 Environmental Compliance and Management Programs Inspection. Shark and stingray species observed/recorded at Hickam AFB by the Hawaii Institute of Marine Biology (Lowe 1996).

APPENDIX K

LETTERS OF COOPERATION FROM FEDERAL AND STATE AGENCIES AND MEMORANDUM OF UNDERSTANDING BETWEEN THE DEPARTMENT OF DEFENSE AND THE U.S. FISH AND WILDLIFE SERVICE FOR THE ECOSYSTEM-BASED MANAGEMENT OF FISH, WILDLIFE AND PLANT RESOURCES ON MILITARY LANDS

POL
13 Apr 08

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
2008-TA-0106

APR 15 2008

Mr. Gary O'Donnell
Chief, Environmental Planning Element
75 H Street
Hickam Air Force Base, Hawaii 96853

Subject: 2008 Final Integrated Natural Resources Management Plan for U.S. Air Force Installations Located in the State of Hawaii

Dear Mr. Gary O'Donnell:

The U.S. Fish and Wildlife Service (Service) has reviewed the revised 2008 Final Integrated Natural Resources Management Plan (INRMP) pursuant to the Sikes Act (16 USAC 670a *et seq*.), the U.S. Air Force prepared in 1997 and updated in 2003. The INRMP is to be revised every five years. The updated INRMP of 2008 outlines a wide variety of biodiversity and conservation goals for five U.S. Air Force installations on the islands of Oahu and Kauai. The installations and sub-installations addressed in this INRMP include: Hickam Air Force Base, Bellows Air Force Station, Hickam POL Pipeline (including Kipapa Fuel Storage Area and Waikakalaua Fuel Storage Area), Kaala Air Force Station on the island of Oahu and Kokee Air Force Station (including Kokee Microwave Antennae Site) on the island of Kauai. The Service reviewed your draft 2008 INRMP and submitted comments in our letter dated October 1, 2007. Broad-based activities include, but are not limited to, native ecosystem rehabilitation and protection, Bird Aircraft Strike Hazard (BASH) program, predator control, invasive plant and erosion control, and increased environmental education and recreation.

We recommend the following minor additions to the final 2008 INRMP:

1. In Chapter 1 Section 1.2 on Authority of the INRMP, specific Federal mandates and agreements to include in this section are Endangered Species Act (ESA), Migratory Bird Treaty Act (MBTA), Comprehensive Environmental Response Compensation and Liability Act (CERCLA), Resource Conservation and Recovery Act (RCRD), Clean Water Act (CWA) section 402 National Pollutant Discharge Elimination System (NPDES), CWA section 404, and Oil Pollution Act (OPA), which currently includes Sikes Act and National Environmental Policy Act (NEPA);

TAKE PRIDE IN AMERICA

Mr. Gary O'Donnell 2

2. In Chapter 4 - multiple sections (one for each installation) have been dedicated to Hazardous Waste Management, so it is clear contaminants will be part of an objective for monitoring trends in resource condition at U.S. Air Force facilities: Please add a statement within these sections that you will look for opportunities to partner with the Service regarding evaluating and addressing contaminant-related and other natural resource issues.

With regard to protection of species listed under the ESA, the Service and U.S. Air Force agree that the INRMP is programmatic in nature and is a planning document. For this reason, we anticipate that consultation under section 7 of the ESA will be undertaken on a project-specific basis prior to implementation of proposed projects. Pursuant to your INRMP it is our understanding the U.S. Air Force will consult on their ongoing actions that have adverse effects on listed species.

Based on our review and coordination, and provided the above additions are incorporated into the final 2008 INRMP, this letter serves to communicate the Service and U.S. Air Force are in mutual agreement with regard to the plan's content, consistent with paragraph (a)(2) of the Sikes Act.

We appreciate the opportunity to work with you to ensure the INRMP addresses natural resource issues on the U.S. Air Force installations. If you have questions regarding this letter or federally protected species, please contact Aaron Nadig, Fish and Wildlife Biologist (phone: 808-792-9400; fax: 808-792-9581).

Sincerely,

For Patrick Leonard
Field Supervisor

cc:
USFWS Region 1
NMFS – PIRO, Honolulu
EPA Region IX, Honolulu
Hawaii DOFAW

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

February 27, 2008

Mr. Aaron Hebshi
Natural Resources Manager
15 CES/CEVP
75 H Street, Hickam AFB, HI 96853

Dear Mr. Hebshi:

SUBJECT: Request for Comments: Final INRMP 15th Airlift Wing, Hickam AFB, Hawaii for 1) Hickam AFB, 2) Bellows AFS, 3) Hickam POL Pipeline, 4) Kaala AFS, and 5) Kokee AFS.

DOFAW will reiterate its comments back in October 23, 2001 and will comment on overall programmatic concerns for the 2007 INRMP relating to the five installations listed above. Priority is requested for procedures and policies adopted by 15th Airlift Wing at Hickam to prevent unwanted introductions of invasive plants and animal species into Hawaii. Hickam Air Force Base is a major port for transpacific flights into Hawaii. For the individual tracking stations listed above, fire management plans is required at all installations and/or fire breaks developed around each station. Public access through military lands to State lands requires continued cooperation between our agencies. We will work with the appropriate military branch staff to agree on opportunities for the public while maintaining national security.

Appendix V – "Response to Comments" of your final INRMP document provides a summary of your responses to various agency review of this document. Based on your responses, DLNR, Division of Forestry and Wildlife will concur with your final INRMP & EA, December 2007, for the Installations listed above. Thank you for allowing DLNR, Division of Forestry and Wildlife the opportunity to review your document.

Sincerely Yours,

Paul J. Conry
Administrator

C: DOFAW Kauai Branch
DOFAW Oahu Branch

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
INTERIM CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

September 5, 2007

JM Waller Associates, Inc.
Carl Woehrle, Program Manager
459 N. Kalaheo
Kailua, Hawaii 96734

Attention: Mr. Carl Woehrle, Program Manager

Gentlemen:

Subject: Draft Integrated Natural Resources Management Plan for Hickam AFB, Bellows AFS, Hickam POL Pipeline, Kaala AFS, and Kokee AFS

Thank you for the opportunity to review and comment on the subject matter. The Department of Land and Natural Resources' (DLNR) Land Division distributed or made available a copy of your report pertaining to the subject matter to DLNR Divisions for their review and comment.

Other than the comments from Division of State Parks, Division of Aquatic Resources, Commission on Water Resource Management, Land Division – Oahu District, Division of Forestry & Wildlife, the Department of Land and Natural Resources has no other comments to offer on the subject matter. Should you have any questions, please feel free to call our office at 587-0433. Thank you.

Sincerely,

Russell Y. Tsuji
Administrator

50487

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

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URAL RESOURCES
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August 10, 2007

MEMORANDUM

TO: **DLNR Agencies:**
x Div. of Aquatic Resources
__Div. of Boating & Ocean Recreation
x Engineering Division
x Div. of Forestry & Wildlife
x Div. of State Parks
x Commission on Water Resource Management
x Office of Conservation & Coastal Lands
x Land Division – Oahu District/Kauai District

FROM: Russell Y. Tsuji
SUBJECT: Draft Integrated Natural Resources management Plan for Hickam AFB, Bellows AFS, Hickam POL Pipeline, Kaala AFS, and Kokee AFS
LOCATION: Oahu and Kauai
APPLICANT: 15th Airlift Wing (15 AW), Hickam Air Force Base, Hawaii

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by September 1, 2007.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

( ) We have no objections.
(✓) We have no comments.
( ) Comments are attached.

Signed:
Date: 8/31/07

AM

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
INTERIM CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

AQUATIC RESOURCES: 1061

DIRECTOR	✓
COMM. FISH.	
AQ RES/ENV	
AQ REC	
PLANNER	
STAFF SVCS	
RCUH/UH	
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AFRC/FED AID	
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MEMORANDUM

TO: ~~DLNR Agencies:~~
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~~Div. of Boating & Ocean Recreation~~
x Engineering Division
x Div. of Forestry & Wildlife
x Div. of State Parks
x Commission on Water Resource Management
x Office of Conservation & Coastal Lands
x Land Division – Oahu District/Kauai District

FROM: Russell Y. Tsuji
SUBJECT: Draft Integrated Natural Resources management Plan for Hickam AFB, Bellows AFS, Hickam POL Pipeline, Kaala AFS, and Kokee AFS
LOCATION: Oahu and Kauai
APPLICANT: 15th Airlift Wing (15 AW), Hickam Air Force Base, Hawaii

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by September 1, 2007.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

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2007 SEP -5 A 10:35
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STATE OF HAWAII

( ) We have no objections.
( ) We have no comments.
(✓) Comments are attached.

Signed: Brandon Duhn
Date: 9-4-07

Suspense Date: 9/1/07

State of Hawaii
Department of Land and Natural Resources
DIVISION OF AQUATIC RESOURCES

Date: 8/30/07

MEMORANDUM
TO: Francis Oishi, Program Manager
FROM: Alton Miyasaka, Aquatic Biologist
SUBJECT: Comments on INRAMP Update for 2008-2012

Comment	Date	Request	Receipt	Referral
Requested by: Russell Tsuji DLNR/Land		8/10/07	8/14/07	8/20/07

Summary of Proposed Project

Title: Draft Integrated Natural Resources Management Plan (INRAMP) Update for 2008-2012

Project by: 15th Airlift Wing, Hickam AFB

Location: Hickam AFB, Bellows, Hickam POL Pipeline, Kaala, and Kokee AFS

Brief Description: The applicant proposes to update the Integrated Natural Resources Management Plan for years 2008-2012 to manage natural resources on five Department of Defense military installations within the context of the operational mission of the facilities. All actions are developed with the intent of protecting cultural and historic resources.

Comments: Based on the information provided, the draft plan update does not appear to raise any concerns relating to the management of natural aquatic resources on DoD installations.

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
INTERIM CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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August 10, 2007

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MEMORANDUM

TO: **DLNR Agencies:**
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__Div. of Boating & Ocean Recreation
x Engineering Division
x Div. of Forestry & Wildlife
x ~~Div. of State Parks~~
x Commission on Water Resource Management
x ~~Office of Conservation & Coastal Lands~~
x Land Division – Oahu District/Kauai District

FROM: Russell Y. Tsuji
SUBJECT: Draft Integrated Natural Resources management Plan for Hickam AFB, Bellows AFS, Hickam POL Pipeline, Kaala AFS, and Kokee AFS
LOCATION: Oahu and Kauai
APPLICANT: 15th Airlift Wing (15 AW), Hickam Air Force Base, Hawaii

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by September 1, 2007.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

(✓) We have no objections.
(✓) We have no comments.
( ) Comments are attached.

Signed: W. Roy Hardy
Date: 8/29/07

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
INTERIM CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

August 10, 2007

MEMORANDUM

From: ~~TO:~~ **DLNR Agencies:**
x Div. of Aquatic Resources
__Div. of Boating & Ocean Recreation
x Engineering Division
x Div. of Forestry & Wildlife
x Div. of State Parks
x Commission on Water Resource Management
x Office of Conservation & Coastal Lands
x Land Division – Oahu District/Kauai District

TO: ~~FROM:~~ Russell Y. Tsuji
SUBJECT: Draft Integrated Natural Resources management Plan for Hickam AFB, Bellows AFS, Hickam POL Pipeline, Kaala AFS, and Kokee AFS
LOCATION: Oahu and Kauai
APPLICANT: 15th Airlift Wing (15 AW), Hickam Air Force Base, Hawaii

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by September 1, 2007.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

( ) We have no objections.
(X) We have no comments.
( ) Comments are attached.

Signed: _____
Date: 8/14/07

Division of Forestry & Wildlife

1151 Punchbowl Street, Rm. 325 • Honolulu, HI 96813 • (808) 587-0166 • Fax: (808) 587-0160

August 22, 2007

MEMORANDUM

TO: Russell Y. Tsuji, Administrator
Land Division

FROM: Paul J. Conry, Administrator
Division of Forestry and Wildlife

SUBJECT: Request for Comments: Draft INRMP 15th Airlift Wing, Hickam AFB, Hawaii for 1) Hickam AFB, 2) Bellows AFS, 3) Hickam POL Pipeline, 4) Kaala AFS, and 5) Kokee AFS.

DOFAW has reviewed its comments back in October 23, 2001 and will comment on overall programmatic concerns for the 2007 INRMP relating to the five installations listed above. Priority is requested for procedures and policies adopted by 15th Airlift Wing at Hickam to prevent unwanted introductions of invasive plants and animal species into Hawaii. Hickam Air Force Base is a major port for transpacific flights into Hawaii. For the individual tracking stations listed above, fire management plans is required at all installations and/or fire breaks developed around each station. Public access through military lands to State lands requires continued cooperation between our agencies. We will work with the appropriate military branch staff to agree on opportunities for the public while maintaining national security. Thank you for including DLNR, Division of Forestry and Wildlife the opportunity to review your INRMP at the 15th Airlift Wing installations described above.

C: DOFAW Kauai Branch
DOFAW Oahu Branch

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2007 AUG 23 P 3:18
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STATE OF HAWAII

LIST OF PREPARERS
2008-2012 INRMP

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Aaron Hebshi, Natural Resources Manager

CONTRACTORS

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Carl Woehrle, Project Manager
Evangeline Baulch
Jesse Woehrle
Luz Brand

SUSTAINABLE RESOURCES GROUP INTERNATIONAL, INC:
Kristin Duin

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2003-2007 INRMP

Name	Degree	Professional Discipline
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Fred L. McGhee	B.S. Linguistics M.A. Anthropology Ph.D. Anthropology	Archaeologist
Gary O'Donnell	B.S. Architecture M.S. Urban Design	Architect, Chief, Environmental Planning Element
CONTRACTORS		
JM WALLER ASSOCIATES		
Patrick Coke	Environmental Technician	Research, QA, and Graphics
Greg Dixon	B.S. Environmental Science	Environmental, Natural Resources & Planning
Gloria Hagge	B.S. Biology M.S. Urban Planning	Project Manager Environmental, Natural Resources & Planning
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June Ortiz	A.S. Psychology	Quality Assurance, Editing
Mike Schneider	B.A. Geography AAS GIS Technology	GIS/Graphics
Terry Scott	B.A. Geography	Environmental, Natural Resources & Planning
Ellen Stutsman		Quality Assurance, Editing
Carl Woerhle	B.S. Electrical Engineering	Program Manager

LIST OF CONTRIBUTORS
ORIGINAL 1997 – 2002 INRMP

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HQ PACAF/CEVP:	Arthur Buckman Robert Landis Greg Lee
15 CES/CEVP:	Gary O'Donnell, Project Manager Capt. Mark Blake Lt. Eric Sosa

CONTRACTORS

BLACK & VEATCH:	William F. Webb
EA ENGINEERING, SCIENCE, AND TECHNOLOGY:	Susan Hootkins, Project Manager Sia Morhardt, Project Director David Chapin, Task Leader Joseph Seppi, Task Leader David Keilly, Task Leader Eloise Anderson JoAnn Aviles Kathy Buell Brad Doorn Ed Gilpin Kim Harper Debbie Hensley Frank Hopkins Sally Koba Ron Langum Andrew League Bill Merrey Alisa Moore Steve Olive Alan Olson Jody Pang

CHAPTER 8
CORALS

CHAPTER EIGHT: CORALS

8.1 DEFINITION OF CORAL AND CORAL REEF

Corals from one or more taxa are present from the North Pole to the South Pole and from the intertidal zone to the abyss. Corals addressed in this document are exclusively tropical species occurring (primarily) at depths of less than 325 ft (100 m).

The Coral Reef Conservation Act of 2000 defines several related terms: coral, coral reef, and coral reef ecosystem as follows.

"CORAL- The term "coral" means species of the phylum Cnidaria, including --

(A) all species of the orders Antipatharia (black corals), Scleractinia (stony corals), Gorgonacea (horny corals), Stolonifera (organpipe corals and others), Alcyonacea [misspelled](soft corals), and Coenothecalia (blue coral), of the class Anthozoa; and

(B) all species of the order Hydrocorallina (fire corals and hydrocorals) of the class Hydrozoa.

CORAL REEF- The term "coral reef" means any reefs or shoals composed primarily of corals.

CORAL REEF ECOSYSTEM- The term "coral reef ecosystem" means coral and other species of reef organisms (including reef plants) associated with coral reefs, and the nonliving environmental factors that directly affect coral reefs, that together function as an ecological unit in nature."

Section III C. of this Deliverable discusses coral taxonomy and points out that there are significant differences of opinion, even among experts. To further clarify the definition of coral and coral reef the following definition is provided. It is not intended to alter the legal definition provided in the Act, but facilitate taxonomic comparisons.

CORAL- The term "coral" means species of the phylum Cnidaria, including --

- Class Hydrozoa Order Milleporina (fire corals also known as Hydrocorallina)
- Class Hydrozoa Order Stylasterina (lace corals also known as Hydrocorallina)
- Class Anthozoa, Subclass Hexacorallia, Order Scleractinia (stony corals)
- Class Anthozoa, Subclass Ceriantipatharia, Order Antipatharia (black corals and wire corals)
- Class Anthozoa, Subclass Octocorallia, Order Alcyonacea (soft corals and Tubipora corals)
- Class Anthozoa, Subclass Octocorallia, Order Gorgonacea (horny corals/sea fans)
- Class Anthozoa, Subclass Octocorallia, Order Helioporacea (blue corals)

8.2 CORAL TAXONOMY AND BIOGEOGRAPHIC REGIONS

Taxonomy is the branch of biology which includes the theory, principals, and process of classifying organisms into established categories. Coral taxonomy is more controversial than taxonomy relating to many other groups of organisms due to the plastic nature of coral skeletons in response to environmental factors. Taxonomic differences of opinion have significant relevance to species-specific management. The taxonomy of many coral species, including members of the following genera (*Acropora, Agaricia, Montastraea, Montipora,* and *Porites*) is contested (Wallace and Willis 1994; Pennisi 2002; Shearer & Coffroth 2006; Willis *et al.* 2006). This can potentially alter the true number of listed/proposed species.

The Hawaiian Archipelago falls within the Hawaii ecoregion, Hawaiian province and the Eastern Indo-pacific biogeographic realm (Spalding 2007). Jokiel (2008) lists about 40 scleractinian species and Randall (2007) lists 612 fish species. The Hawaiian ecoregion has suffered a significant decline in the distribution, diversity and abundance of coral reef organisms during the last 40 years (NOAA and Hawai'i Coral Reef State of the Reefs).

8.3 GENERAL NAVY PRACTICES WHICH BENEFIT CORALS AND NEAR SHORE MARINE NATURAL RESOURCES

There are scores of environmental protection and natural resource standard practices, guidance documents and policies (hereafter referred to as practices) which the Navy routinely implements. While some of these practices were not originally designed specifically to benefit corals and coral reefs the net result has been extremely beneficial to corals, coral reefs and a myriad of associated organisms including shell fish, fin fish and sea turtles. These practices can be broadly divided into six major categories: (1) INRMPs; (2) terrestrial pollution control and land management practices; (3) vessel pollution control practices; (4) construction management practices; (5) bio-security practices; and (6) installation- specific practices. It should be noted that many installation specific practices have been adopted and are funded based upon a legally operative and approved INRMP. Below is a brief example of how these practices have benefitted corals; the example is followed by abbreviated summaries of standard practices which benefit corals, coral reefs and associated marine natural resources.

Pearl Harbor provides an example of 'indirect' benefits these practices provide. Until the 1960s Navy vessels discharged waste water into Pearl Harbor and shore waste water received little or no treatment. No corals were present or recorded from Pearl Harbor at that time (Evans *et al*. 1974). With the adoption of stringent practices to control terrestrial and vessel pollution as well as the implementation of strict land management and construction management techniques water quality improved and marine resources thrived. Today there are 13 different species of coral found in Pearl Harbor, fishery target species are abundant and numerous invertebrates like the pearl oyster are returning (Smith *et al*. 2006; Smith personal communication 2010).

Daszak et al. (2000), Worm et al. (2006) and many other investigators have noted that coastal development and associated activities are having increasingly adverse impacts upon coastal ecosystems around the world. These impacts have resulted in the severe degradation of many coral reefs and their associated flora and fauna. During the last decade, ecologists have discovered that while many publicly accessible coastal areas are declining, marine natural resources in areas under DOD control, with little or no public access, are thriving and/or in significantly better condition than adjacent areas. Stein *et al.* (2008) demonstrated that DOD-restricted marine areas support three times the densities of ESA status species and imperiled species as are found on public lands. Marine

resources within these DOD controlled areas are generally healthier, more abundant, and larger than those outside.

Many anthropogenic stressors that have highly deleterious impacts upon coral reefs and the associated flora and fauna are either completely absent in DOD controlled areas or experienced at much lower levels of intensity than in public coastal zones. Anthropogenic stressors include, but are not limited to those presented in Table 8-1.

Table 8-1 Common Coral Reef Stressors Absent or Reduced at DOD Sites

Stressors	Stressors
Reef walking	Grounding of personal watercraft
Skin /Scuba Diving	Untreated sewage discharge personal watercraft
Spear fishing	Improper/inadequate waste water disposal
Trap & net fishing	Improper/inadequate storm water runoff disposal
Hook & line fishing	Illegal dumping of hazardous materials/waste
Jet skiing	Improper/inadequate erosion control
Motorized personal watercraft	Harassment of marine life by beachgoers
Collection of corals & invertebrates for the aquarium trade	Reduced water quality from large volumes of Sun block
Anchor damage from commercial, recreational & private boaters	Improper disposal of refuse, particularly plastics, diapers, pull tabs, bottle caps and cans

Non-consumptive recreational activities, like reef walking and skin/scuba diving can have a profound negative long-term adverse impacts to corals, coral reefs and associated marine resources; this fact has been well established by numerous investigators worldwide (e.g., Sudara and Nateekarnchanalap 1988; Harriott, Davies and Banks 1997; and Van Treech and Schumacher 1998). These types of activities are banned or greatly restricted at DOD properties, thus reducing or eliminating the associated adverse impacts.

Consumptive recreational and commercial activities, primarily fishing and the collection of aquarium specimens adversely impact corals/coral reefs as well as the species actually captured. Raymundo *et al*. (2009) clearly demonstrated that functionally diverse and healthy reef-fish communities reduce the incidence of coral disease. Raymundo *et al.* (2009), Smith *et al.* (2006) and other investigators have shown that MPAs and DOD restricted marine areas support significantly higher fish diversity and biomass than adjacent public areas. These healthier, more natural fish populations play a key role in maintaining healthier corals and coral reefs on DOD properties.

The elimination and/or reduction many of the other stressors listed in Table 8-1 are discussed in Section V of this document. A review of the management and enforcement activities of MPAs worldwide will show that few, if any, actually have the level of protection, management and enforcement

that is present at DOD facilities. Cook *et al.* (2010) stated "Comprehensive review of available evidence shows major, rapid benefits of no-take areas for targeted fish and sharks, in both reef and non-reef habitats, with potential benefits for fisheries as well as biodiversity conservation…reserves also appear to benefit overall ecosystem health and resilience…".

DOD ecosystem-based management

While DOD-controlled marine areas have the positive benefits of restricted commercial and recreational activities on nearshore tropical resources, including no commercial fishing, limited recreational marine resource extraction, no commercial water-based recreational activity, and no industrial/wastewater discharges on ranges, DOD base commanders and resource managers also actively implement ecosystem-based management to magnify effects on coral reef systems. This ecosystem-based management includes the following actions:

- Sustainably managing the degree of access, use and exploitation of marine natural resources;
- Effectively managing the terrestrial portion (watershed) of the military installation bordering the maritime area; and
- Influencing the management of coastal land-based ecosystems, terrestrial runoff, and coastal and upland human development outside of the DOD facility.

The above DOD environmental-stewardship actions appear to have greatly enhanced the condition of the resource above what it would likely be if not managed. This ecosystem-based management also generates a spill-over effect into non-DOD surrounding areas, and in sum creates a net conservation benefit to the resource

DOD ecosystem-based management of coral reef systems and adjacent watersheds not only yields important science-based natural resources information important for the effective regulation and management of endangered and threatened species, but it also fosters compliance with international treaties (e.g. Convention on International Trade in Endangered Species [CITES]) and national and international initiatives (e.g., the US Coral Reef Initiative and the International Coral Reef Initiative). These efforts also help conserve and restore critical habitat for these species and minimize the need for listing of additional species.

Integrated Natural Resource Management Plans

All Navy installations with significant natural resources are required to prepare INRMPs, in compliance with the SAIA (Public Law 105-85). INRMPs must provide for:

- Conservation and rehabilitation of natural resources
- Sustainable multi-purpose uses of resources; and
- Public access for use of natural resources, subject to the Navy's mission, operational and security requirements.

Federal agencies are required by the ESA to manage federally listed threatened and endangered species and their habitats in a manner that promotes their conservation and is consistent with recovery plans for such species. INRMPs serve as the key vehicle through which Navy installations meet this requirement for threatened and endangered species located on Navy facilities. Section 7 of the ESA and the SAIA require that the Navy enter into consultation with the USFWS and NOAA Fisheries whenever actions are proposed that may affect listed and proposed threatened and endangered species.

Rigorous surveys and/or investigations of corals and/or the two threatened and endangered listed coral species have been conducted at NAS Key West, SFOMF, Naval Station Pearl Harbor, Pacific Missile Range Facility (PMRF), Naval Base Guam and the Farallon De Medinilla and Tinian Military Lease Areas. At many of these sites, long term coral assessment and monitoring coral programs have been in effect for more than five years. For those sites at which long term studies are underway, it has been shown that corals, coral reefs and associated organisms are, in fact more robust and healthy than in adjacent areas which are not under Navy control.

The Navy's legal and actual ability to control navigation, anchoring, mooring, construction, diving, fishing and other activities, combined with Navy INRMPs and the myriad of additional standard environmental and natural resource practices ensure that corals, coral reefs and associated organisms at Navy facilities will benefit in many ways, including, but not limited to the following:

- The cumulative benefits of the management activities will ensure the maintenance or increase of the species population and enhance and/or restore habitat, baring uncontrollable natural disasters or events such as global sea surface temperature increases. Through implementation of the INRMPs and adherence to requirements of other practices (e.g., CWA) the Navy can ensure that all proposed actions that could potentially affect corals and coral reefs are in compliance with Section 7 of the ESA and other relevant guidance documents.
- The Navy's INRMP plans and other practices will be implemented. Personnel charged with implementing plans and practices are capable of accomplishing the objectives and have the funding and authority to do so.
- The management effectiveness of these plans and practices has been demonstrated and documented in previous sections of this document and will be further documented in following sections.

OPNAV Instruction 5090.1C is the Environmental Readiness Program Manual from the Chief of Naval Operations dated 30 October 2007. This document discusses requirements, delineates responsibilities, and issues policy for the management of the environmental, natural and cultural resources for all Navy ships and shore activities. The Navy is committed to operating successfully in a manner compatible with the environment. The mission of the Navy's Environmental Readiness Program is to ensure the ability of the United States Navy forces to effectively operate world-wide in an environmentally responsible manner, both ashore and afloat. Navy, joint and combined operations and training must be planned and executed to fully meet operational readiness requirements and Navy environmental objectives. In order to ensure that the Navy can prepare, train and operate as required, personnel must be aware of the environmental requirements established by federal, state and local laws and regulations; EOs; and DOD and Navy policy. National defense and environmental protection are, and must continue to be, compatible goals. Achievement of these goals requires the leadership and personal commitment of military and civilian personnel throughout the Navy chain of command. Sections within multiple chapters of OPNAVINST 5090.1C have direct and indirect relevance to preserving water quality in the marine environment. Maintaining and improving water quality is essential to protecting and enhancing corals and coral reefs as well as the associated invertebrates, fishes and sea turtles.

Please see Section 3.4.1.4 for discussion on Invasive Species.

8.4 CORAL RESOURCE DESCRIPTION AND MANAGEMENT

Distribution of corals

Spalding (2007) place the Hawaiian Archipelago within the Hawaii ecoregion, Hawaiian province and the Eastern Indo-pacific biogeographic realm. Jokiel (2008) lists about 40 scleractinian species and Fenner (2005) lists 66. Coral diversity in the Hawaiian Islands is comparable to that found in the Western Atlantic and Caribbean, both have less than 1/10th the number of coral species found in Guam and CNMI. However, diversity is only one measure of the biological importance of a coral reef and the Hawaiian reefs are significant from an ecological, commercial, recreational and cultural perspective.

Pearl Harbor can be divided into two major components, the harbor itself and the adjacent offshore area. The harbor is surrounded by land on all sides, with only a narrow connection to the ocean. It is subdivided into four lochs (West, Middle, East and South East Lochs). A fossilized reef platform extends approximately one nautical mile offshore from the Pearl Harbor shoreline. A natural channel cuts through the fossilized reef platform. The natural channel has been dredged and modified and is now designated as the Pearl Harbor Entrance Channel. The waters of Pearl Harbor, the Pearl Harbor Entrance Channel and the adjacent areas for approximately three nautical miles south and four nautical miles east and west are designated as Naval Defensive Sea Area. The NDSA encompasses the western half of the Honolulu International Airport Reef Runway.

Within Pearl Harbor itself, extensive coral surveys were conducted in 1973/1974, 1999, 2002, and on a roughly quarterly basis from 2002 to the present. Although there are no coral reefs within Pearl Harbor, the number and size of coral colonies and the locations at which they occur appears to be increasing.

The Pearl Harbor Entrance Channel consists almost entirely of unconsolidated sediment. As one proceeds offshore the sand and rubble become increasingly coarse. The sides of the Pearl Harbor Entrance Channel, and the adjacent fossilized reef platform do support substantial coral, including some of Oahu's best coral reefs. The reefs on the western side of the Pearl Harbor Entrance Channel are the most highly developed, with the greatest coral diversity and reef complexity. The depths at which these reefs are the most well developed range from 15 ft to 60 ft. The percent sea floor cover by stony corals outside of the Pearl Harbor Entrance Channel but within the NDSA exceeds 25% in many areas (Smith, unpublished data 2010). These values are comparable to, or higher than most other areas on the island of Oahu. The total number of scleractinian coral species present within the NDSA outside of the entrance channel is at least 25. Two species included in the proposed listing (*Montipora patula* and *Montipora flabellata*) are present in Pearl Harbor and common outside the channel.

Degredation of Hawaii's near shore marine resources was noted as early as 1902 (Jordan and Everman); fisheries were said to be declining rapidly due to overfishing. Over the last 40 years the Hawaiian ecoregion has suffered a significant decline in the distribution, diversity and abundance of coral reef organisms (NOAA 2008). Overfishing and destructive fishing methods impact not only fish, but all the associated marine resources, particularly coral. Depleted stocks of herbivorous fish make coral more vulnerable to bleaching events, over-growth by algae and disease in general. In more recent times, the aquarium trade has further stressed Hawaii's reefs by removing colorful (non-food) fishes as well as invertebrates living on and in coral heads, such as feather duster worms, hermit crabs and coral shrimp. It should be noted that these extractive practices are having and have had a strong negative impact upon corals, corals reefs and the associated ecosystem in Florida, the Virgin Islands, and Guam as well as in Hawaii. Riegl et al. (2008) state: "…marine resources in Hawaii have steadily declined over the last century…". This decline has also been due to a wide range of other factors, including, but not limited to: poor land use practices, oil, pesticide and heavy metal pollution, increased sedimentation, sewage discharge, shoreline filling, increased small boat traffic and anchoring, and

tourist and recreational diving. While Pearl Harbor does not support coral reefs, the presence of 13 species in 2006 suggests that current conditions in some areas are conducive to coral growth. In addition, Smith et al. (2006) showed that many fishery target species in Pearl Harbor were not only more abundant, but larger than specimens outside. For example, the whitesaddle goatfish (*Parupeneus porphyreus*) which commands the highest ex-vessel price of any Hawaiian inshore fish, was observed on seven of 23 transects in Pearl Harbor and had an average estimated weight of 950 g. On 290 transects off Lanai and 49 off Waikiki (both better quality habitats) none of these fish were observed. These fish estimates were all performed by Dr. Richard Brock of the University of Hawaii, who also noted that when this species is seen outside Pearl Harbor it rarely exceeds 120 g in size.

Land and Jurisdictional Issues

The Naval Defensive Sea Area (NDSA) off Oahu was established through Executive Order 10140. It was intended to protect coastal areas of military significance. However, since the terrorist attach of September 11, 2001 use of and access to the NDSA has been extremely limited.

There are no designated Navy Submerged Lands located within or adjacent to Pearl Harbor NDSA.

The Western Pacific Regional Fishery Management Council has designated all the waters around all the Main Hawaiian Islands as Essential Fish Habitat (EFH) from the shoreline to a depth of 1,300 ft (400 m) for one or more of the managed species. Therefore all of Pearl NDSA is EFH. However, no EFH Habitat Area of Particular Concern has been designated for any of these Navy areas.

Disputes have arisen within Pearl Harbor over the removal and eradication of the red mangrove (*Rhizophora mangle*). This species was intentionally introduced to Hawaii approximately 100 years ago. In Pearl Harbor it occupies much of the shoreline. Land which has accreted as a result of the spreading mangroves is claimed by both the State of Hawaii and by the Navy. The U.S Fish and Wildlife Service, the State of Hawaii, and community groups have urged the Navy to remove mangroves; the Navy has complied with these requests and in 2008 instituted a mangrove removal program. While no corals are present within the mangroves, mangroves serve as a natural filter and may have helped improve water quality. Continued removal of the mangroves may have an adverse impact upon both corals and fishes within Pearl Harbor. But to date, approximately 1/3 of all mangroves have been removed from the Pearl Harbor shoreline while water quality continues to improve.

The National Wildlife Refuge Honouliuli Unit and the National Wildlife Refuge Waiawa Unit are located on the shores of Pearl Harbor's West Loch and Middle Loch, respectively. These refuges are intended primarily to provide improved bird habitat. The waters adjacent to both these refuges are subject to substantial natural fresh water input and terrigenous discharges. As a result, the levels of total suspended solids and turbidity are high, salinity is reduced and the sea floor is very fine unconsolidated sediment, primarily mud. These areas are not suitable for successful coral recruitment. In spite of extensive surveys, no corals have ever been observed adjacent to or within a nautical mile of either of these refuges.

Key factors influencing corals

There are two primary factors impacting corals within Pearl Harbor, fresh water input from streams and springs, and the spread of invasive algae. Approximately 70% of the freshwater input to Pearl Harbor is derived from a complex of springs including Waiau Springs, Waimano Springs, Waiawa Springs and Waikele Springs (Nichols et al. 1996). The pre-development discharged rates were estimated to be up to 183 million gallons per day, making this the largest spring complex in the Hawaiian Islands and one of the largest known for all the Pacific Islands. The most significant streams discharging into the harbor

are Halawa Stream and Waimalu Stream. Corals are limited by low levels of salinity, so the discharges from these springs and streams has and will continue to limit the spread of corals within the harbor. The Navy has no control over upstream dumping into the streams. Unfortunately, substantial quantitative of hazardous materials and hazardous waste, such as motor oil, batteries and paints are illegally dumped into these streams which discharge into Pearl Harbor. The contaminants from these streams may not be sufficient to limit the distribution of corals in the harbor, but are certainly detrimental.

The State of Hawaii has intentionally introduced a number of algal species. They were intended to provide a basis for aqua culture industries. However, several species have spread out of control and had a severe adverse impact to corals and coral reefs throughout the Main Hawaiian Islands. The most serious threat within Pearl Harbor is from the red algae *Gracillaria salicornia.* This algae has spread rapidly between 2005 and the present. Some areas within Pearl Harbor, which had begun to support substantial coral communities in 2005 had been partially or completely overgrown and killed by late 2009. It is interesting to note that in spite of the spread of this algae, the total biomass of coral appears to have increased since 2005. This is due to the recruitment and spread of corals at depths below 20 ft, where light levels are too low to support *Gracillaria salicornia,* and to the recruitment of corals to higher energy areas, like Hospital Point. *Gracillaria salicornia* does not appear to be able to tolerate the wave energy levels that are encountered in some areas of the harbor, thereby allowing corals to successfully recruit to areas as shallow as 3 ft.

Fishing within Pearl Harbor has been restricted for more than 10 years. Although not intended to benefit corals, the result has been highly significant. The large number of herbivorous fishes and generally healthy fish fauna have undoubtedly contributed to the recovery and spread of corals (Raymundo et al. 2009 and Smith et al. 2006).

In the Pearl Harbor Entrance Channel and NDSA waters outside the channel, neither fresh water input nor invasive algae are a significant issue. Due to its geographic location and restrictions on access to the area, including access by fishermen and divers, there are no chronic threats to the corals and coral reefs in this zone with the exception of regional or global threats such as increase sea surface temperatures. In February 2009 the USS Port Royal ran aground in the eastern portions of the within the NDSA outside of Pearl Harbor. Corals were damaged and destroyed as a result of the grounding. While highly regrettable, such incidents are extremely rare. Sport and commercial fishing and aquarium fish collection take place at the eastern and western edges of the NDSA off of Hickam and Iroquois Point. This fishing includes the use of wire fish traps which are often lost and remain on the sea floor catching fish for years. Further reduction or control of fishing from the NDSA would be highly beneficial to corals.

The most significant factor affecting coral reefs in the NDSA outside of the entrance channel is believed to be big wave events. At intervals of approximately 10 years, exceptionally large wave events occur and destroy many of the shallow reef areas to depths of 15 to 25 ft. Hurricanes Iwa (1982) and Iniki (1992) crushed many corals along the south shore of Oahu to beds of loose rubble that prevented subsequent recruitment for many years (Grigg – date?).

Operational and training requirements

With two exceptions, there are no routine operational or training requirements that could reasonably be expected to have an adverse impact on corals or coral reefs in the NDSA if standard Navy practices are followed. Of course, in the event of an accident, such an oil spill, or ship grounding significant adverse impacts to corals could occur.

The two exceptions mentioned above are: tug boat towing operations and underwater detonation training in the Pu`uloa underwater training area (UNDET). When tug boats tow barges or vessels in and out of Pearl Harbor they normally align themselves in the center line of the Pearl Harbor Entrance Channel. However, there has been at least one occasion in which a tug cut the corner of the Entrance Channel. By (apparently) cutting the corner and simultaneously slowing down the towing chain or cable contacted the sea floor at depths between 50 and 60 ft resulting in a swath of broken coral. This would have been avoided if the tug had properly aligned itself in the Entrance Channel.

Underwater detonation training is conducted on roughly a quarterly basis at the UNDET range. The UNDET range is located on the west side of the Entrance Channel. Most portions of the range consist of a sand and or sand/rubble sea floor. There are some biologically significant coral patch reefs within the UNDET range. In the past, potential impacts to those small, isolated patch reefs have been avoided by having explosive ordnance disposal (EOD) divers survey the site to ensure that no corals or other sensitive marine natural resources are in proximity to the detonation site. This practice has been effective and should be continued in the future.

Section VIII discusses proactive Navy procedures that are employed to protect the environment, all of which directly or indirectly help safeguard and/or benefit corals and coral reefs.

Additional Navy practices which benefit corals and associated organisms

Installation specific practices.

The most important practice that has benefitted coral, in addition to those described in Section VIII A, B, C and D, is the restriction of fishing and diving activities. The fish stocks throughout the Main Hawaiian Islands are severely depressed (e.g. Riegl et al. 2008); this fact has had and continues to have an adverse impact on corals and coral reefs. Fishing restrictions and the limitations on access in the NDSA have allowed the fish stocks to return to more 'normal' levels (Smith et al. 2006). It is important to note that since the attack of September 11, 2001 public diving in the NDSA outside of the entrance channel has been curtailed. This has substantially reduced pressure from commercial and recreational spear fishermen and aquarium collectors with consequent increases in the number of fin fishes and sought after shell fish from all trophic levels (Smith, personal communication 2010). Research has shown that such changes are beneficial to corals and coral reefs (e.g. Raymundo et al. 2009).

Pearl Harbor has established and implemented clear goals and objectives to protect and conserve its natural resources. These include the following:

1. Protect, conserve and manage terrestrial and aquatic flora and fauna.

2. Proactively manage/monitor threatened and endangered or otherwise protected species. This effort includes monitoring of corals and sea turtles in the NDSA.

3. Maintain baseline information on aquatic resources and fisheries.

4. Prevent the introduction of new non-indigenous aquatic species.

5. Work to improve water quality and contaminant levels to improve the health of the marine ecosystem.

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CHAPTER 9
IMPLEMENTATION PLAN

CHAPTER NINE: IMPLEMENTATION PLAN

9.1 INTRODUCTION

Natural resources management actions to be funded by CNRH and executed by CNRH and JBPHH will be completed in order to manage natural resources within the context of the military mission. This implementation plan includes adaptive management options for conserving and protecting native habitat and threatened and endangered species and other protected species while providing natural resource based outdoor recreation opportunities for base residents, personnel, and visitors.

Should the JBPHH military mission or security requirements change, natural resources management actions could conflict with the new mission/requirements. In such cases, a reevaluation and adjustment of natural resources management actions may be necessary.

9.2 MANAGEMENT RESPONSIBILITIES

NAVFAC HI is the primary party responsible for implementing the INRMP on behalf of the JBPHH Installation's Commanding Officer. COMPACFLT is responsible for ensuring implementation of certain projects and SOPs, as stipulated in their training authorizations from the regulatory agencies. The JBPHH IEPM is the primary on-site points of contact for all day-to-day natural resources management issues, concerns, plans, projects, facilities planning, design and construction, security services, and outdoor recreation. The JBPHH IEPM is also responsible for raising staff and community awareness about conserving unique resources and protecting threatened and endangered species. NAVFAC HI and COMPACFLT, with the support of NAVFAC PAC, coordinate natural resource management projects with relevant agencies and provide support to those same agencies in their efforts to manage species and ecosystems associated with JBPHH lands and waters.

NAVFAC HI's Environmental Planning branch is responsible for planning, budgeting, and monitoring the progress of the INRMP management actions on a programmatic level. Progress monitoring includes scheduling or conducting periodic evaluations, making mid-course adjustments when needed, and documenting follow-up actions. NAVFAC HI Environmental Planning branch also provides reachback support to the JBPHH IEPM for day-to-day operations that require specialized natural resources expertise. NAVFAC PAC provides this reachback support to the COMPACFLT Hawaii Range Sustainment Environmental Coordinator. NAVFAC PAC directly supports projects for which COMPACFLT is responsible for implementing, and provides execution oversight, financial management oversight, and reachback support to NAVFAC HI. Many of the management actions provide opportunities for the Navy to partner with key federal and SOH resource agencies (USFWS, NOAA Fisheries, USDA, DLNR), and various county agencies, community organizations, non-profits, environmental groups, and schools.

9.3 PROPOSED ACTIONS

The current management sections of the installation chapters (i.e. Sections 3.4 -6.4) describe the requirements and goals for natural resource management at JBPHH. Sections 9.3.1 through 9.3.5 provide descriptions of planned natural resources management actions at JBPHH. For each natural resources program element, there are two categories of financial support: (1) normal operating costs (NOC) (e.g., comes from base operations); and (2) funded projects. There are three funding priorities which are summarized in Table 9-1. Section 9.8 provides a summary of Navy funding programs. Table 9-8 (at the end of this chapter) presents the 10-year fiscal plan for the implementation plan actions and projects.

Because the INRMP is a public document that requires the mutual agreement of the installation and Working Group members, it is important to have a common understanding regarding projects contained in the plan that are most likely to be funded under existing policy. INRMP funding reflects an annual strategy that addresses legal requirements. As the Working Group defines objectives, identifies legal drivers, and collaborates with each other to develop land and natural resource management goals, the subsequent outcome is a list of projects necessary to implement the INRMP. This project list includes "must fund" compliance-type projects as well as stewardship-type projects.

There is also a DOD budget scheme which includes four classes (0 through 3). Class 0, recurring natural and cultural resources conservation management requirements, includes INRMP actions necessary to rehabilitate or prevent source degradation that may affect military readiness. Class 1, current compliance requirements, includes requirements to manage species and habitats of concern to prevent listing of species that could affect military readiness. Class 2, current maintenance requirements, includes projects and activities needed that are not currently out of compliance, but would be out of compliance if projects or activities are not implemented in time to meet an established deadline. Class 3, enhancement actions beyond compliance, includes projects and activities that enhance conservation resources or the integrity of the installation mission, or are needed to address overall environmental goals and objects, but are not specifically required under a regulation or EO and are not of an immediate nature.

Table 9-1: Funding Priorities

Funding Priority	Description
Priority 1	Priority 1 projects are those that would meet the definition for Class 1 funding. These are actions that are required within the current fiscal year in order to correct a noncompliance situation.
Priority 2	Priority 2 projects meet the definition of Class 2 funding. These are actions that are required to remain in compliance with legal requirements or to meet established deadlines. Priority 2/Class 2 funding ensures continued compliance with laws and regulations or efforts needed to meet established deadlines.
Priority 3	Priority 3 projects are feasible actions that would enhance natural resources, but are not required to comply with laws or regulations or to meet established deadlines. Funding for Class 3 actions may not be readily available. If funds are provided, the Priority 3 projects could be initiated in the order proposed by the JBPHH IEPM and approved by the appropriate command structure. Priority 3/Class 3 funding is for all other enhancement projects

9.3.1 PHNC Proposed Actions

Table 9-2 provides a summary of the recommended management actions for PHNC. These recommended actions along with their 10-year fiscal plan are listed in Table 9-8 (end of the chapter).

Table 9-2: Recommended Management Actions for PHNC

Item No.	Recommendation	Management Action	Funding
1	**Regulatory agency coordination**: In accordance with EO 13352, the JBPHH IEPM, NAVFAC PAC Natural Resources staff, and the NAVFAC HI Natural Resource Program Manager will continue to coordinate with federal and SOH agencies on natural resources issues pertaining to threatened and endangered species, critical habitat, species of concern, MBTA bird species, and invasive species.	Protected Species and Ecosystems Monitoring and Management	P2/ NOC
2	**Protected bird species management, monitoring and reporting:** Management actions described in Section 3.4.1.1 for Hawaiian waterbirds, white terns, Hawaiian short-eared owls, and MBTA-protected bird species will be continued in addition to other projects described below. These include population monitoring, appropriate resource agency coordination, maintaining and updating cooperative agreements and SOPs, and conducting project reviews and consultations that may affect listed bird species.	Protected Species and Ecosystems Monitoring and Management	P2/C2
3	**Hawaiian waterbird banding and resighting study:** This project calls for the banding and/or radiotracking of Hawaiian waterbirds around the south shore of Pearl Harbor and Lualualei to better understand population source and sink dynamics and identify where additional wetland management can be conducted to provide the most benefit to the birds. This study should be done in collaboration with USFWS refuges, who manages breeding waterbirds at the Honouliuli PHNWR and Waiawa PHNWR (and who intends to begin a tracking program themselves), and the Hickam component of JBPHH, who is interested in understanding stilt movements as it relates to BASH risk. This project can be implemented as a citizen science program, whereby banded birds are resighted by interested citizens and/or Navy employees/sailors and their families, and called in to a central database managed by NAVFAC Hawaii.	Protected Species and Ecosystems Monitoring and Management	P2/C2
4	**Hawaiian bat acoustic surveys:** The USGS has developed a standardized detection protocol for Hawaiian hoary bats using an acoustic detection unit. These units are mounted in the field for several days to a month and record presence or absence and frequency of bat calls. These surveys should be conducted at Red Hill and West Loch.	Protected Species and Ecosystems Monitoring and Management	P2/C2

Table 9-2: Recommended Management Actions for PHNC (Continued)

Item No.	Recommendation	Management Action	Funding
5	**Hawaiian monk seal monitoring and protection:** JBPHH personnel will employ a number of SOPs and management actions in order to protect monk seals that haul out on the beach or are observed injured or struggling in nearshore waters. The Navy will upgrade the management actions discussed in Section 3.4.1.1 and summarized below. • JBPHH environmental personnel maintain their training and contacts with NOAA's Marine Mammal Stranding Network to execute a quick response to any beaching or entanglement events on JBPHH beaches or nearshore waters. Coordination with NOAA Fisheries for any associated necropsies, if required, will also be ensured. • JBPHH personnel will continue to record all sightings of monk seals and report tag numbers to NOAA Fisheries. To ensure protection from disturbance, any animals hauled up on the beach within the public use area will be cordoned off by security forces and reported to JBPHH IEPM. • JBPHH will continue to restrict recreational shore fishing to designated areas (Section 3.4.6) in order to reduce the probability of entanglement with stray fishing line while still providing some recreational opportunities, and to promote healthy nearshore reef-fish stocks. • JBPHH will continue to restrict dogs off leashes along the beach to limit the potential for seal-dog interactions. • JBPHH will continue to control feral animals (dogs) on base that can transfer diseases to monk seals. • The Navy will continue to ensure training activities do not affect hauled-out seals at JBPHH beaches. Prior to conducting a beach landing exercises, Navy observers will survey beaches for Hawaiian monk seals. Should a monk seal be found on the beach, the landing will be delayed until the animal has voluntarily left the area. • JBPHH will continue to sponsor marine debris clean up events.	Protected Species and Ecosystems Monitoring and Management	P2/NOC/ C2
6	**Maintain/update SOPs for protection of ESA-protected species:** The Navy will continue to update SOPs (Appendix I) with regard to ESA-protected species. These SOPs instruct Navy personnel in how to respond to situations involving ESA-protected species that are known to occur at JBPHH.	Protected Species and Ecosystems Monitoring and Management	P2/C2
7	**Management actions for rare and protected species during training activities:** The Navy will update SOPs and other management actions detailed in the *Final Programmatic Biological Opinion on U.S. Navy Activities in the Hawaii Range Complex 2008- 2013* (NOAA Fisheries 2008) and *the Hawaii Range Complex FEIS/OEIS* (DON 2008a) including: • Fencing and signage used to mark the presence of rare and/or protected species; • Protections for rare and/or protected species during personnel bivouacking; • Marine mammal collision avoidance and encounter reporting; • Underwater detonations during personnel training; and • Protection of rare and/or protected species during amphibious inserts..	Protected Species and Ecosystems Monitoring and Management	P2/NOC C2
8	**Marine debris reduction:** The Navy will continue to seek ways to reduce the amount of waste generated by its afloat forces. Many Navy ships will continue to meet or exceed existing legal requirements regarding waste management. Navy ships will continue to retain all plastics on board, melting and compressing the accumulated materials for land-based recycling or disposal. Navy members will continue to routinely remove marine debris from Pearl Harbor and PHEC and will continue to work in partnership with other agencies in removing derelict fishing gear caught on the ocean floor in NWHI.	Protected Species and Ecosystems Monitoring and Management	P2/NOC

Table 9-2: Recommended Management Actions for PHNC (Continued)

Item No.	Recommendation	Management Action	Funding
9	**Provide staff focused, annual natural resources training:** The Navy will provide focused annual training for JBPHH Environmental Storefront Coordinators in order to improve and enhance programs for endangered species protection and invasive species detection. Training and outreach materials will include Hawai'i Department of Agriculture's pest hotline (643-PEST). This number can be used to report snakes, red imported fire ant, coqui frog, invasive plants and other suspicious creatures. In addition, training will include coqui frog identification materials.	Protected Species and Ecosystems Monitoring and Management (natural resources awareness)	P2/C2
10	**Maintain security restrictions:** For the purposes of security, public safety, and the interests of the military mission, the Navy will continue to work with DLNR Division of Conservation and Resources Enforcement to restrict access to the shoreline and waters of Pearl Harbor. This restriction has created a *de facto* marine fisheries reserve at Pearl Harbor. JBPHH will continue the restriction of shoreline fishing and boating in designated areas within Pearl Harbor (Section 3.4.6). These restrictions provide a conservation benefit to the natural resources located in these areas.	Protected Species and Ecosystems Monitoring and Management (access restrictions)	P2/NOC/ C2
11	**Conserve Waiawa Watershed as a natural area:** The Navy will continue to maintain the majority of the Waiawa watershed area in its natural state to provide hydrogeologic benefits, flood control, and benefits to wildlife, including aquatic species.	Protected Species and Ecosystems Monitoring and Management (access restrictions)	P2/NOC
12	**Predator control at PHNC**: The Navy will initiate predator control around wetland areas at PHNC and Hickam AFB, focusing on feral/stray cats.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
13	**Pearl Harbor biosecurity plan:** An inspection program for cargo being loaded for shipment and cargo being received, from U.S. ports, Guam, or overseas, is to be initiated. Currently, only overseas cargo is inspected. Key items to search for include live plants, soil, snakes, rodents, or arthropod-infested goods. A biosecurity plan should be coordinated with other Navy installations to ensure efficiencies in inspection plan development. The biosecurity plan also calls for the maintenance of a high level of cleanliness at shipping and receiving ports at Pearl Harbor. This includes a consistent high level of rodent baiting and trapping, well-lit open areas at night, no open areas of dirt and/or vegetation near storage facilities or loading docks, and no piles of debris or open rubbish receptacles that provide harborage or resources for rodents and other pests.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
14	**Invasive species biosecurity SOPs:** The Navy will update SOPs for personnel training and provide natural resources information to personnel relocating to JBPHH. The Navy will continue to require decontamination (cleaning) of all vehicles, equipment, personal gear, shoes, and clothing before personnel may enter a training area at PHNC in order to minimize the introduction of invasive species. The JBPHH IEPM will provide information about invasive species to be included in "Welcome Aboard" packages for incoming Navy personnel. Natural resources information includes the effects of alien plant and animal species to native ecosystems and federally-listed threatened and endangered or otherwise protected species.	Protected Species and Ecosystems Monitoring and Management (invasive species)/ Community Outreach	P2/C2

Table 9-2: Recommended Management Actions for PHNC (Continued)

Item No.	Recommendation	Management Action	Funding
15	**Control alien plants:** The JBPHH IEPM will continue to evaluate and prioritize invasive noxious plants to be controlled, with emphasis on newly emerging weeds or those species or populations encroaching on healthy native plant populations and habitats, such as wetlands and native montane and mesic forests. The prevention and control of weed populations will continue to be incorporated into a written updates to the INRMP.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
16	**Mangrove and pickleweed removal in Pearl Harbor. :** CNRH will continue to control the mangrove growing in biologically sensitive (e.g., native bird habitat) and culturally sensitive (e.g., fishponds) areas and important view planes along the Pearl Harbor shoreline (Section 3.4.1.6). The Navy will continue to support USFWS in their efforts to remove mangrove growth along the shoreline at Honouliuli Unit of PHNWR. Wildlife needs will be evaluated in the context of alien plant control measures. For example, wetland areas will not be completely cleared of vegetation, as dense growth provides important habitat for endangered, endemic waterbirds. Phase 3 of mangrove removal program around Pearl Harbor calls for 102 ac (41 ha) around West and Middle Lochs. The program saw success using heavy mechanical removal to date, and future removal should also employ heavy removal using excavators and tub grinders around visible areas. Remote areas of Waipi'o Peninsula and Ford Island can be sprayed, if it is deemed to be more cost effective and efficient. Rodeo or Aquamaster are two approved herbicides for mangroves in wetland areas. Habitat has also proven to be successful in a mangrove control project on the Big Island. When adult mangroves are removed, young mangrove propagules germinate and will quickly replace what was not removed. Therefore, continued maintenance via hand-pulling and spraying of propagules is necessary until the propagule bank has been depleted. Annual maintenance for cleared sites can be sufficient in keeping mangroves from reclaiming cleared areas. Maintenance can be performed in-house with the assistance of NAVFAC HI pesticide shop, and with the assistance of the outreach program of Navy Region Hawaii who can recruit Navy and community volunteers. Pickleweed control can also be conducted via hand-pulling or herbicides. However, hand-pulling often leaves part of the below-ground root structure, which grows back quickly. Hand-pulling is best conducted with the use of spades to remove as much of the root structure as possible. This is effective for small and/or newly invaded areas.	Protected Species and Ecosystems Monitoring and Management (invasive species and wetlands)	P2/C2
17	**Reduce and prevent the release of AIS:** The Navy will continue to comply with OPNAV 5090.1C., UNDS and federal policies and guidelines regarding the discharge of ship's ballast water (Section 3.4.1.4) as well as other appropriate measures to reduce the introduction of alien species into Pearl Harbor. The Navy will continue to support interagency and public and private initiatives to reduce the release of alien aquatic species into upland streams. CNRH will work with CNIC and CNO on guidelines for comp water management and decommissioned vessel fouling management. The Navy will continue to raise awareness of the potential harm AIS can cause to Hawai'i's sensitive ecosystems.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/NOC/ C2
18	**Bilge and ballast purge:** The Navy will continue to request that multinational participants in training activities purge bilge and/or ballast tanks in their ships prior to entering U.S. territorial water (Section 3.4.1.4).	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/NOC

Table 9-2: Recommended Management Actions for PHNC (Continued)

Item No.	Recommendation	Management Action	Funding
19	**Invasive algae control and early detection of incipient marine invasive species:** This project calls for the deployment of the super sucker (a large marine vacuum mounted on a barge and operated by the Nature Conservancy of Hawaii) into Pearl Harbor to control areas where *Gracilaria salicornia*, the invasive "gorilla ogo seaweed" has formed a thick impenetrable mat. Areas cleared will need to be monitored to document recovery or re-invasion. This work can be contracted through the Nature Conservancy directly or through SOH DAR.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
20	**Early detection roadside surveys:** The O'ahu Early Detection Program conducts roadside surveys of military installations in search of incipient invasive plants. This program is funded by the State Invasive Species Committees, and is operated out of the Bishop Museum. This program can be supported by providing access to program personnel on a regular basis (annually or less frequently).	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
21	**Revegetation with native plants:** Restored and intact native habitats provide vital ecosystem services such as clean water, topsoil retention, and nesting and foraging areas for native species. When practicable, native species from O'ahu (preferably JBPHH locations) will be used in landscaping, replanting, recovery, and other conservation efforts. The JBPHH IEPM may promote participation with interested parties.	Protected Species and Ecosystems Monitoring and Management (natural resources restoration)	P2/C2
22	**Pearl Harbor wetland and riparian ecosystem restoration plan:** This project calls for the development of a multi-partnered plan, with Navy as the lead, to restore riparian and wetland areas of Pearl Harbor and adjacent lower watersheds. This plan should encompass mangrove control, native wetland plant restoration, invasive aquatic fish control, riparian buffer zones, and management of urban contaminant inputs through source identification and outreach. Key Navy personnel involved in this plan include the Navy Region Hawaii outreach coordinator, encroachment management coordinator, natural resources manager, and storm and waste water managers. Partners should include DOH, CCH, kindergarten through grade 12 schools in the lower Pearl Harbor watershed areas, and community groups such as the Aiea Community Association.	Protected Species and Ecosystems Monitoring and Management (natural resources restoration /wetlands)	P2/C2
23	**Wetlands management:** The Navy will continue its wetlands management policies described in Section 3.4.1.6. These include protecting wetlands from dredging, filling, or otherwise destroying without proper permits and necessary minimization and mitigative measures (i.e., no net loss of wetlands). In addition, the Navy will coordinate any wetland enhancement efforts with appropriate federal and SOH agencies. The Navy will continue to promote wetlands mitigation banking. The Navy will continue to ensure that planning staff receive formal, annual training on wetlands regulations and policy in order to properly identify, manage, and protect installation wetlands in accordance with "no net loss of wetlands" values.	Protected Species and Ecosystems Monitoring and Management (wetlands)	P2/NOC
24	**Update wetlands survey:** The Navy will update wetlands surveys at Pearl Harbor (Section 3.4.1.6) prior to the next INRMP update in order to continue to identify and manage these wetlands.	Protected Species and Ecosystems Monitoring and Management (wetlands)	P2/C2
25	**INRMP annual and 5-year updates:** Continue to update Navy metrics builder, meet with INRMP Working Group Members, and update document as required.	Natural Resources Studies	P2/C2

Table 9-2: Recommended Management Actions for PHNC (Continued)

Item No.	Recommendation	Management Action	Funding
26	**Update/initiate installation-wide flora and fauna mapping:** The Navy will update flora and fauna surveys and mapping at all sites (Sections 3.3.3, 3.3.5, 3.4.2,) in order to protect, conserve, and manage plant and animal species and expand database on potential listed species across the installation at 5-year intervals in preparation for subsequent INRMP updates. Navy Natural Resources personnel will continue to coordinate with DLNR-DOFAW and DAR as well as USFWS to collect population-monitoring data for protected species. Population monitoring data will continue to be evaluated for any necessary changes or improvements in management actions. Botanical surveys will also include early detection for species of concern that may be new to Leeward O'ahu or species that may be new to the island. Findings will be shared with the O'ahu Invasive Species Committee (OISC) so that OISC can conduct delimiting surveys on lands bordering Navy property if necessary. Bird surveys will include discussion and recommendations for habitat restoration opportunities.	Natural Resources Studies	P2/C2
27	**Update marine resources and fisheries survey:** The Navy will fund a follow on survey to the 2006 characterization of fish and benthic communities of Pearl Harbor and PHEC (Smith *et al* 2006). The survey will assist JBPHH in their continued efforts to protect and conserve ESA-protected species at PHNC. In addition, the Navy will fund annual surveys which will also include monitoring of invasive algae distribution and detection of incipient invasive species.	Natural Resources Studies	P2/C2
28	**Study the effects of fishing on Pearl Harbor with a creel survey:** In response to a growing concern over whether fishing should be allowed in the harbor both from a fishery conservation aspect and from a public health aspect, the Navy will fund a study to examine the effects of fishing on the harbor. A creel survey will be done to determine how much fishing is occurring, where it is occurring, what species are being caught, and how much fish is being kept for consumption. The survey will be conducted around Pearl Harbor to document the compliance or lack thereof of fishers, and their employment of BMPs for catch-and-release fishing to minimize harm to fish. This survey will provide background information for a revised JBPHH fishing policy, which should be drafted in 2011.	Natural Resources Studies/ Outdoor Recreation	P3/C3
29	**Coastal wetland and dryland restoration study:** Coastal/wetland and dryland restoration techniques have been poorly developed in Hawai'i. Given the near elimination of native coastal habitats, re-engineering these ecosystems requires significant research on large scale invasive species removal and revegetation techniques. This type of research should be coordinated with off-site researchers at the University of Hawai'i or through the Legacy Funding Program (Section 9.8). Endangered stilt populations may be significantly increasing at Pearl Harbor as a result of mangrove removal. Accurate censuses, in conjunction with the State Waterbird survey, should be conducted to determine benefit to listed species. In addition, banding of stilts will allow biologists to better understand movements among sites and can assist in documenting high-value sites that provide stable foraging and/or breeding conditions.	Natural Resources Studies	P3/CL
30	**Feasibility study for aquatic invasive species control:** Invasive aquatic species removal, particularly *Gracilaria salicornia*, may or may not be possible at Pearl Harbor. A feasibility study and pilot project should be conducted to attempt different control techniques using manual removal devices (e.g. DAR's supersucker) and/or urchin translocations.	Natural Resources Studies	P3/C3
31	**Natural resource GIS data management:** JBPHH will continue to manage, integrate, access and report natural resources GIS data into JBPHH GIS database (Section 2.4), with major inputs anticipated during 5-year floral/faunal survey updates associated with INRMP revisions. GIS data will also be continually uploaded into RSIMS for early planning by facilities managers	GIS	P2/C2

Table 9-2: Recommended Management Actions for PHNC (Continued)

Item No.	Recommendation	Management Action	Funding
32	**Develop a GIS layer for mature and significant trees and landscapes:** GPS mapping of mature and significant trees on developed Navy lands is recommended by the NAVFAC Hawaii Landscape Architect. The Navy will develop a GPS-based GIS map layer indicating the location of known mature and significant trees and landscapes that could be included in CNRH's geodatabase.	GIS/Forestry	P3/C3
33	**Protect mature and significant trees, landscapes, and pocket forests:** Facility managers from JBPHH will be required to get approval from the JBPHH XO prior to removing any tree within the installation (Section 3.4.4). Species of trees that are invasive would not be protected. In cases where the tree provides an important function (shade, for example) replacement with a non-invasive tree will be considered. JBPHH will prepare an instruction for this requirement.	Forestry	P2/NOC
34	**Continue standard provisions in construction/landscape contracts:** Continue to include standard provisions in all construction and landscape contracts regarding procedures to follow when working near mature and/or significant trees and landscapes (Section 3.4.4). Contract landscapers will also be instructed to plant non-invasive species when choosing plants for ornamental purposes. Species can be checked for potential high risk at www.wra.org or hpwra@yahoo.com.	Forestry/Land Management	P2/NOC
35	**Promote awareness of ESA- and other protected species and natural resources stewardship:** Pearl Harbor's natural resource protection efforts need to be highlighted internally, to the public, and to other agencies. This promotion will increase ecological literacy on base, facilitate relationships with the public and outside agencies, and promote dialogue with other natural resource managers and scientists leading to the development of better and more efficient management practices. The Navy will continue to promote awareness of ESA- and other protected species and natural resources stewardship among JBPHH personnel and residents through on-going educational efforts such as printed material in "Welcome Aboard" packet, signs in ecologically sensitive areas (e.g., wetlands, forests), promotion of community service projects at PHNWR Honouliuli and Waiawa Units, beach cleanups, and natural resources brochures at selected locations. The Navy will create a specific educational plan to alert residents/personnel about the impacts of feral cat and dog populations on native wildlife and the importance of keeping the feral population of these animals away from PHNWR. The Navy will support increased public outreach to children's groups and other community groups to increase the public's awareness of the natural resource value of Pearl Harbor. The Navy will include natural resource articles in Navy quarterly newsletters, such as the FISC newsletter, and bi-weekly activity postings. The Navy will increase the frequency of public mangrove removal events. The Navy will develop community partnerships to restore fishponds and wetlands, shared waterfronts, storm-water monitoring. The Navy will develop school partnerships for outreach to Pearl Harbor area K-12 schools. The Navy will increase inreach with security forces.	Community Outreach	P3/ NOC
36	**Support PHNWR Honouliuli and Waiawa Units:** Support and encourage the use of Navy community service program volunteers including the MWR single sailor program to provide exotic vegetation control, maintenance, and wetland habitat enhancement projects at the USFWS-managed Honouliuli and Waiawa Units of the PHNWR that are located on Navy lands. In addition, when reasonable, the Navy will support increases in the acreage of PHNWR units.	Community Outreach	P3/NOC
37	**Promote public education on hazards of fish consumption:** The Navy will continue to support SOH DOH in its efforts to provide public education regarding: (1) the health risks of consuming fish and shellfish from Pearl Harbor; (2) the importance of non-consumption of fish and shellfish from the harbor; and (3) the Navy's actions to cleanup impacted areas around the harbor. Continue to maintain posted advisories around the harbor shoreline in conjunction with the SOH DOH.	Community Outreach	P3/NOC/ C3

Table 9-2: Recommended Management Actions for PHNC (Continued)

Item No.	Recommendation	Management Action	Funding
38	**Support identification and mitigation of public health risks:** The Navy will continue to support SOH DOH efforts to identify and mitigate public health risk associated with consumptive fishing within Pearl Harbor. These may include epidemiological surveys to identify potentially at-risk groups, quantities of fish/shellfish consumed, and level of risk. The Navy will continue to work cooperatively with SOH DOH to share data and identify/implement appropriate mitigation actions.	Community Outreach	P3/NOC
39	**Water and sediment quality and public health:** The Navy will continue the ongoing Navy RI/FS program for Pearl Harbor in order to protect human health and the environment (Section 3.4.7).	Community Outreach	P2/C2
40	**Continue to support a public overlook at PHNWR Honouliuli Unit:** The Navy will continue to be supportive of USFWS efforts to build a public overlook at PHNWR Honouliuli Unit in order to provide outdoor recreational activities to JBPHH personnel and the general public.	Community Outreach	P3/NOC
41	**Adopt a waterfront:** Community groups/schools can adopt a waterfront to maintain it from rubbish, invasive species, and dumping, feral cat feeding, and native habitat restoration.	Community Outreach	P3/NOC
42	**Storm-water stenciling:** Stenciling of storm drains in and around Pearl Harbor can provide an educational opportunity to community members. NAVFAC Hawaii's stormwater manager can couple with Navy Region Hawaii's outreach coordinator to conduct storm-water stenciling events with the participation of community groups and schools.	Community Outreach	P3/C3
43	**Protect fishpond walls:** The Navy will develop a community outreach program to monitor the Loko Pa'aiau, Loko Laulaunui, Loko Pamoku, and Loko 'Oki'okiolepe (within Pearl Harbor). If necessary, the program would promote the control and management of the vegetation in order to preserve and protect the fishpond walls.	Community Outreach	P2/C2/ NOC
44	**Continue to support Rainbow Bay Marina:** MWR will continue to provide outdoor recreational services for authorized personnel at Rainbow Bay Marina (Section 3.4.6).	Outdoor Recreation	P3/NOC
45	**Continue recreational catch-and-release fishing and study the effects of fishing on the harbor:** MWR will continue to promote catch-and-release fishing at Pearl Harbor (Section 3.4.6, CNRH Instruction 5510.20C). In addition, in response to a growing concern over whether fishing should be allowed in the harbor both from a fishery conservation aspect and from a public health aspect, the Navy will fund a study to examine the effects of fishing on the harbor. A creel survey will be done to determine how much fishing is occurring, where it is occurring, what species are being caught, and how much fish is being kept for consumption.	Outdoor Recreation	P3/NOC/ C3
46	**Continue to support bicycling, jogging, and walking:** The Navy will continue to support bicycling and jogging along the Pearl Harbor Bike Path and self-guided walking tours of historic Ford Island (Section 3.4.6).	Outdoor Recreation	P3/NOC
47	**Continue to promote public outdoor recreation events:** The Navy will continue to promote public events at PHNC including fun runs and canoe regattas (Section 3.4.6).	Outdoor Recreation	P3/NOC
48	**Hunting ungulates for outdoor recreation:** A program to authorize hunting of feral ungulates with dogs and knives will be encouraged at low-land degraded sites such as Red Hill, Makalapa Crater, and West Loch.	Outdoor Recreation/ Land Management	P3/CL3

Table 9-2: Recommended Management Actions for PHNC (Continued)

Item No.	Recommendation	Management Action	Funding
49	**Base planning:** The Navy will continue base planning management actions to protect natural resources (Section 3.4.7). A routine procedure will continue to be implemented to assure coordination among facilities planners, resource managers, SOH, and CCH officials. The NAVFAC HI Natural Resources Manager will continue to be the point of contact to provide relevant information on issues with potential to affect waterbirds, such as sound levels, direct habitat loss due to clearance and construction, proximity to neighboring habitats, and sensitivity of the birds to disturbance. Natural resources surveys may be required and mitigation measures developed to assure protection of federally-listed threatened and endangered or otherwise protected species and their habitats. The Navy will continue the current policy of pollution reduction for JBPHH, including the identification of sources of pollutants in the harbor and their reduction/elimination. The Navy will continue to utilize BMPs during earthwork, construction, and the design of storm drainage systems. The Navy will continue to work with SOH, CCH, and private landowners in the Pearl Harbor Watershed to reduce non-point source pollution into the harbor.	Land Management	P2/NOC
50	**Landscape design:** The JBPHH IEPM will continue to evaluate all future landscape design and installation projects for the potential to include habitat restoration and the use of native plants whenever possible. The preference for native plant materials from O'ahu, as well as the importance of using sterile soil to prevent the introduction of pests, such as nematodes, will continue to be emphasized. When choosing plants for landscape design, landscapers will consult the Weed Risk Assessment (WRA) (www.hear.org/wra) to ensure the species area not potentially invasive. The WRA analyzes a species' biology and history in Hawai'i to determine if it poses a high risk of becoming invasive. Species not listed on the website can be assessed for potential high risk by contacting hpwra@yahoo.com.	Land Management	P2/NOC
51	**Prevention of point source pollution:** The Navy will continue the current policy of pollution reduction for JBPHH, including the identification of sources of pollutants in the harbor and their reduction/elimination (Section 3.4.7).	Land Management	P2/NOC
52	**Soil stabilization and erosion control:** The Navy will continue to utilize BMPs during earthwork, construction, and the design of storm drainage systems (Section 3.4.7).	Land Management	P2/NOC
53	**Replant eroded landscapes:** The Navy will replant the bare, eroded ridge top at Red Hill with appropriate vegetation (e.g., native trees in the vicinity of water tank, grass sprigs around the air vents).	Land Management	P2/C2
54	**Land management restrictions during training maneuvers:** The Navy will continue to prohibit vehicle traffic off existing roads, use of rocks from rock piles or walls for training purposes, establishment of new vehicle tracks during personnel maneuvers. In addition, during personnel maneuvers, digging, including entrenchments and foxholes, will continue to be prohibited except in areas specifically designated by the training coordinator. No new placement of barbed wire or concertina wire near signs marking the presence of sensitive ecological areas or fences will be allowed by personnel during maneuvers. No road, trail, or fire break clearing will be allowed during personnel maneuvers without permission from the training coordinator. No grading or construction of buildings or other permanent structure will be allowed without permission from the training coordinator (Sections 3.4.7).	Land Management	P2/NOC
55	**Law enforcement:** A conservation officer will be hired to enforce natural resources and other environmental compliance-related laws, regulations, and instructions.	Law Enforcement	P2/NOC/ C2
56	**Maintain security fencing and firebreaks:** The Navy will continue to maintain current security fencing and firebreaks to minimize the fire hazard at Waiawa Watershed and Red Hill Storage Area (Section 3.4.10).	Wildland Fire	P2/NOC

Table 9-2: Recommended Management Actions for PHNC (Continued)

Item No.	Recommendation	Management Action	Funding
57	**Emergency fire fighting by personnel during training exercises:** In case of fire during personnel training exercises, all fires will be reported to the FFD and personnel will stop training and begin to fight the fire. Personnel will continue to fight the fire until released by the fire department (Section 3.4.10)	Wildland Fire	P2/NOC
58	**Monitor off-site development:** The Navy will continue to monitor adjacent, off-site development for compatibility at all sites (Section 3.4.11).	Leases and Encroachment Management	P2/NOC
59	**Agricultural outleases:** The Navy will seek to maintain and/or increase agricultural opportunities at Pearl City Peninsula and West Loch. Opportunities exist at PHNC, specifically Waipi'o Peninsula and West Loch, to lease land to native plant growers. Potential lessees would clear land invaded by kiawe and buffel grass and plant native plants for eventual selective harvest and resale. This provides some habitat restoration benefit, as well as funds that can be diverted back into the natural resources program. Money collected from these leases is to be directed back into the natural resource programs. Funding for this project will cover administrative costs, such as a NEPA, ECP and Soil and Water Conservation Plans, for initiating new outleases.	Leases and Encroachment Management	P3/C3

9.3.2 Lualualei Proposed Actions

Table 9-3 provides a summary of the recommended management actions for JBPHH's Lualualei Study Area. These recommended actions along with their 10-year fiscal plan are listed in Table 9-8 (end of the chapter).

Table 9-3: Recommended Management Actions for Lualualei

Item No.	Recommendation	Management Action	Funding
1	**Regulatory agency coordination**: In accordance with EO 13352, the JBPHH IEPM, NAVFAC PAC Natural Resources staff, and the CNRH Natural Resource Program Manager will continue to coordinate with federal and SOH agencies on natural resources issues pertaining to threatened and endangered species, critical habitat, species of concern, MBTA bird species, and invasive species.	Protected Species and Ecosystems Monitoring and Management	P2/ NOC
2	**Protected bird species management, monitoring and reporting:** Management actions described in Section 4.4.1 for Hawaiian waterbirds, Hawaiian short-eared owls, and MBTA-protected bird species will be continued in addition to other projects described below. These include population monitoring, appropriate resource agency coordination, maintaining and updating cooperative agreements and SOPs, and conducting project reviews and consultations that may affect listed bird species.	Protected Species and Ecosystems Monitoring and Management	P2/C2

Table 9-3: Recommended Management Actions for Lualualei (Continued)

Item No.	Recommendation	Management Action	Funding
3	**Hawaiian waterbird banding and resighting study:** This project calls for the banding and/or radiotracking of Hawaiian waterbirds at Niuli'i Ponds to better understand population source and sink dynamics and identify where additional wetland management can be conducted to provide the most benefit to the birds. This study should be done in collaboration with USFWS refuges, who manages breeding waterbirds at the Honouliuli PHNWR and Waiawa PHNWR (and who intends to begin a tracking program themselves), and the Hickam component of JBPHH, who is interested in understanding stilt movements as it relates to BASH risk. This project can be implemented as a citizen science program, whereby banded birds are resighted by interested citizens and/or Navy employees/sailors and their families, and called in to a central database managed by NAVFAC Hawaii.	Protected Species and Ecosystems Monitoring and Management	P2/C2
4	**Maintain/update SOPs for protection of ESA-protected species:** The Navy will continue to update SOPs (Appendix I) with regard to ESA-protected species (Section 4.3.1). These SOPs instruct Navy personnel in how to respond to situations involving ESA-protected species that are known to occur at JBPHH.	Protected Species and Ecosystems Monitoring and Management	P2/NOC
5	**O'ahu 'elepaio monitoring and management:** These surveys should be conducted for the next 5 years during the early stage of the breeding season in March to validate the existence/absence of any breeding pairs within formerly known territories. Also, participation in the O'ahu 'elepaio management working group should occur to ensure that Navy interests are represented with respect to island-wide management decisions. Once large tracts of fencing are installed in the SMAs and feral ungulates are excluded from sensitive areas, rodenticide can be broadcast aerially to reduce/control rat populations much more cost effectively. This project will protect rare and endangered snails, seeds/seedlings from rare and endangered plants, and, potentially, O'ahu 'elepaio if any are still present. Rodenticide applications require significant up-front planning and regulatory coordination, but is ultimately approved by the State Of Hawai'i Department of Health. Fencing is required to exclude ungulates prior to rodenticide application because of the potential risk to pig hunters who may consume meat tainted with rodenticide.	Protected Species and Ecosystems Monitoring and Management	P2/C2
6	**Hawaiian bat acoustic surveys:** The USGS has developed a standardized detection protocol for Hawaiian hoary bats using an acoustic detection unit. These units are mounted in the field for several days to a month and record presence or absence and frequency of bat calls. These surveys should be conducted at Lualualei.	Protected Species and Ecosystems Monitoring and Management	P2/C2
7	**NAVMAG PH Lualualei Hawaiian picture wing fly and other arthropod surveys:** This project calls for arthropod surveys in Lualualei to be conducted on an annual basis in order to detect presence/absence of listed, candidate, or proposed species, incipient invasive species, and invasive ants. Native arthropod surveys are to focus on damselflies, picture-wing flies, yellow-faced bees, and the rhyncogonus weevil. Incipient invasive surveys should search and identify areas where there appears to be changes in vegetation health of native plant species. Ant surveys are to pay particular attention to big-headed ants, fire ants, and yellow crazy ants. When these species are detected, local control should be initiated using specialized ant bait.	Protected Species and Ecosystems Monitoring and Management	P2/C2

Table 9-3: Recommended Management Actions for Lualualei (Continued)

Item No.	Recommendation	Management Action	Funding
8	**NAVMAG Lualualei stream bioassessments:** Puhawai stream has been found to be free of fish in its upper reaches, and annual surveys should continue here for damselflies and other native aquatic fauna. While Puhawai stream is the only perennial stream in Lualualei, other intermittent streams in the valley should likewise be surveyed for native aquatic species as well as threats from invasive species. Also a hydrogeologic assessment of water extraction from puu kailio is to be conducted to recalibrate water usage and the potential for redirecting of water back into Puhawai stream.	Protected Species and Ecosystems Monitoring and Management	P2/C2
9	*Amastra cylindrical* **management:** To protect *Amastra cylindrical* in critical endangerment of becoming extinct, the following measures are to be conducted: rat control, invasive predatory snail control, and pisonia habitat improvement. Rats should be controlled through bait stations and/or snap traps. Snap traps should be weather resilient. Bait used should be non-appealing or protected from slug consumption, as an increase in slug populations will draw in additional predatory snails which may then pose a greater risk to *Amastra*. Weather-proof snap traps or multi-kill traps, are highly recommended. Predatory *Euglandina* snails should be searched for and destroyed during monitoring and rat-control visits to the site. Pisonia trees in this stand should be protected from encroachment by Christmas berry and other weeds. Weed control should be on a gradual basis to not shock the system quickly by suddenly increasing the percentage of open canopy. Recommend that no more than 15% of the canopy is opened at any one time. Also, a feasibility study should be conducted to determine if and how a satellite population of *Amastra* should be established in another pisonia grove at Lualualei.	Protected Species and Ecosystems Monitoring and Management	P2/C2
10	*Achatinella mustelina* **management:** To protect this rare endangered snail (*Achatinella mustelina)*, continuous monitoring of the sites for *Euglandina* snails and chameleons should be performed. *Euglandina* and chameleons are to be controlled when detected. This could be conducted by Army personnel working to fulfill their obligations to protect *Achatinella* under their Makua Implementation Plan, as well as Navy and contractor personnel during visits to the Amastra site.	Protected Species and Ecosystems Monitoring and Management	P2/C2
11	**Monitoring and management of NAVMAG PH Lualualei Branch listed/candidate/species of concern plant species:** Annual status assessments of endangered plants throughout NAVMAG Lualualei will be conducted. Rodent control and invasive vegetation within a few meters from endangered plants will be cleared to reduce predation and interference competition. Exclosures at Pu`u Hapapa and Halona protecting Abutilon sandwicense and other rare plant species will be maintained. In situ propagation, through collection and sowing of seeds in the field, is a valuable conservation tool but requires SECNAV approval. A propagation plan should be developed and staffed up the command for approval. Seeds of listed plants, which are currently being stored at Lyon Arboretum, required a Section 10 collection permit from USFWS. Any plant propagation would likewise require a permit, and all outplanted listed plants would need to be designated as "experimental" so as not to further encumber the installation. The NAVFAC HI Natural Resources Program Manager will continue to coordinate with DLNR-DOFAW and USFWS on status of listed plants species, and population monitoring data will continue to be evaluated for any necessary changes or improvements in management actions.	Protected Species and Ecosystems Monitoring and Management	P2/C2

Table 9-3: Recommended Management Actions for Lualualei (Continued)

Item No.	Recommendation	Management Action	Funding
12	**Fencing and signage used to mark presence of rare and/or protected species:** The Navy will continue to prohibit facility maintenance activities in areas marked by signs or fences indicating the presence of rare and/or protected species. In addition, signs will be installed and maintained around the *Abutilon menziesii, Marsilea villosa, and Cyperus trachysanthos* at Lualualei.	Protected Species and Ecosystems Monitoring and Management	P2/C2
13	***Abutilon menziesii* , *Marsilea villosa*, *Cyperus trachysanthos* monitoring and management:** This project calls for annual monitoring of *Abutilon menziesii*, *Marsilea villosa*, and *Cyperus trachysanthos*. In addition, this project would conduct kiawe/buffel grass control around the plants. Clearing can be conducted in-house using hand tools. Careful monitoring after clearing takes place should be conducted to ensure that the plants respond positively. Annual monitoring data should track fate of individual plants, using aluminum markers or flagging, and any new germination is to be documented.	Protected Species and Ecosystems Monitoring and Management	P2/C2
14	**Provide staff focused, annual natural resources training:** The Navy will provide focused annual training for JBPHH Environmental Storefront Coordinators in order to improve and enhance programs for endangered species protection and invasive species detection. Training and outreach materials will include Hawai'i Department of Agriculture's pest hotline (643-PEST). This number can be used to report snakes, red imported fire ant, coqui frog, invasive plants and other suspicious creatures. In addition, training will include coqui frog identification materials.	Protected Species and Ecosystems Monitoring and Management (natural resources awareness)	P2/C2
15	**Maintain security restrictions:** JBPHH will continue to restrict access to native forested areas within NAVMAG PH Lualualei Branch. These restrictions provide a conservation benefit to the natural resources located in these areas.	Protected Species and Ecosystems Monitoring and Management (access restrictions)	P2/NOC
16	**Predator control at Niuli'i Ponds:** JBPHH will continue to contract with USDA-WS for predator control in waterbird habitat areas at Niuli'i Ponds, NRTF Lualualei (Section 4.4.1.1). The Navy will consult with the Service on potential incidental take of endangered Hawaiian moorhen associated with predator control activities.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
17	**Invasive species biosecurity SOPs:** The Navy will update SOPs for personnel training and provide natural resources information to personnel relocating to JBPHH. The Navy will continue to require decontamination (cleaning) of all vehicles, equipment, personal gear, shoes, and clothing before personnel may enter a training area at Lualualei in order to minimize the introduction of invasive species. BMPs will be developed for cleaning gear, equipment, supplies and boots and clothing prior to personnel and equipment accessing sensitive areas within NAVMAG Lualualei. Because several ant species have not been detected in Lualualei, special care should be made to ensure that ants are absent from any gear being packed or helicopter lifted into Lualualei for construction of fencing or other conservation operations. The Navy will provide information about invasive species to be included in "Welcome Aboard" packages for incoming Navy personnel. Natural resources information includes the effects of alien plant and animal species to native ecosystems and federally-listed threatened and endangered or otherwise protected species.	Protected Species and Ecosystems Monitoring and Management (Invasive Species)	P2/NOC

Table 9-3: Recommended Management Actions for Lualualei (Continued)

Item No.	Recommendation	Management Action	Funding
18	**Control alien plants:** The NAVFAC HI Natural Resources Program Manager will continue to evaluate and prioritize invasive noxious plants to be controlled, with emphasis on biocontrol of prickly pear cactus, and control of newly emerging weeds. The prevention and control of weed populations will continue to be incorporated into a written updates to the INRMP.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
19	**Monitor, control ,and exclude feral ungulates within SMAs:** This project includes development and implementation of a fencing strategy to fence larger tracts of sensitive land at Lualualei NAVMAG. Fencing should focus on the SMAs (Figure 4-1), and may be erected to tie into existing fences on the Honouliuli side of the Wai'anae Ridge managed by the Army and Division of Forestry and Wildlife. Halona Valley should receive priority for large-scale fencing due to the large number of rare species and significant stands of native forest. This project also includes work with the Wai'anae Mountain Watershed Partnership to jointly eradicate goats across the Wai'anae Range, except in areas that the state can control for hunting. USDA or DLNR/DOFAW has the expertise to conduct aerial and ground hunting of goats. Pig hunting within fenced areas can be conducted via a permitted hunter program initially and ultimately via use of a contractor to ensure eradication.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
20	**Hunting to control feral ungulates:** A program to authorize hunting of feral ungulates with dogs and knives will be encouraged at degraded sites (i.e., areas without protected species). A permitted hunter program can charge fees to hunters wishing to gain access to the installation, and CNRH would need to develop rules and guidelines for permitted hunters, to be coordinated with Security Forces. Fees would be re-directed, via the Navy-wide hunting program, back to conservation and enforcement efforts at Lualualei.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
21	*Euglandina* **control techniques:** *Euglandina*, a snail species, which prey on native and endangered snails, have been minimally controlled in high-value snail areas by hand collecting, and most recently by the Army with the assistance of detection dogs. The Army also has built a snail enclosure to keep out *Euglandina*. However, *Euglandina* control over larger scales requires the development of a bait and/or trap. Development of effective baiting or trapping strategies could be funded by the DOD Legacy Program, or through a cooperative agreement to the University of Hawai'i for product development. A new bait could receive an emergency exemption, under Section 18 of FIFRA, for temporary use.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
22	**Chameleon detection and control:** Chameleons, which have been found to prey on native and endangered snails and native insects at Lualualei, have been detected in native forest in Lualualei. Because of their cryptic nature, they are difficult to detect and therefore control. The development of an efficient detection system is necessary for effective control. Similar to the *Euglandina* control project, a chameleon control project could be funded through the DOD Legacy Program or a cooperative agreement with a University.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2

Table 9-3: Recommended Management Actions for Lualualei (Continued)

Item No.	Recommendation	Management Action	Funding
23	**Native habitat management through invasive vegetation removal at SMAs in NAVMAG Lualualei:** Invasive vegetation is to continue to be removed using a combination of herbicide application and manual removal. The focus will be on stands of native forest within the SMAs and around listed plants throughout the forested area of the installation. Invasive vegetation removal is to center on Christmas berry, silk oak, guinea grass, haole koa, and *Toona ciliata*. Herbicide application and removal over canopy species should not allow greater than 25% canopy clearing at any one time. Seedlings of invasive trees can be removed at the 100% rate in managed areas. High-resolution aerial imagery, coupled with ground-survey verification, can identify areas of high priority of invasive vegetation management. These areas would include locations where new invasive species are encroaching, or areas high in native and endangered species.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
24	**Black-stem borer research:** Research into the bio-control or pheromone/chemical control of black stem borers can be supported through a cooperative agreement with the University of Hawaii. The Navy will work with other stakeholders to provide funding to investigate methods to control this non-native insect that is impacting listed species.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
25	**Peafowl seed predation study:** Peafowls in NAVMAG Lualualei have been documented to consume fruits of native tree species such as Antidesma. Peafowl droppings are to be collected in the Halona exclosure where native seeds are known to be consumed. They will be grown in a greenhouse to identify if native or other seeds germinate. If no seeds germinate, or if only invasive seeds germinate, this will indicate the need to control peafowl in the area, which are becoming locally abundant.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
26	**Early detection roadside surveys:** The O'ahu Early Detection Program conducts roadside surveys of military installations in search of incipient invasive plants. This program is funded by the State Invasive Species Committees, and is operated out of the Bishop Museum. This program can be supported by providing access to program personnel on a regular basis (annually or less frequently).	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
27	**Revegetation with native plants:** Restored and intact native habitats provide vital ecosystem services such as clean water, topsoil retention, and nesting and foraging areas for native species. When practicable, native species from O'ahu (preferably JBPHH installations) will be used in landscaping, replanting, recovery, and other conservation efforts. The JBPHH IEPM may promote participation with interested parties.	Protected Species and Ecosystems Monitoring and Management (natural resources restoration)/Land Management	P2/C2
28	**Wetlands management:** The Navy will continue its wetlands management policies as described in Section 3.4.1.6. These include protecting wetlands from dredging, filling, or otherwise destroying without proper permits and necessary minimization and mitigative measures (i.e., no net loss of wetlands). In addition, the Navy will coordinate any wetland enhancement efforts with appropriate federal and SOH agencies. The Navy will continue to promote wetlands mitigation banking. The Navy will continue to ensure that planning staff receive formal, annual training on wetlands regulations and policy in order to properly identify, manage, and protect installation wetlands in accordance with "no net loss of wetlands" values.	Protected Species and Ecosystems Monitoring and Management (wetlands)	P2/NOC

Table 9-3: Recommended Management Actions for Lualualei (Continued)

Item No.	Recommendation	Management Action	Funding
29	**Niuli'i Ponds Management:** Develop management plan for endangered Hawaiian waterbird species at Niuli'i Ponds Wildlife Refuge at NRTF Lualualei. Water level will continue to be maintained through the use of the water timer, but may be lowered during the fall non-breeding season in order to control vegetation by reducing overall emergent cover of California grass and cattails. This has efficiently been executed in the past through the BOS contractor that supports the Lualualei Branch.	Protected Species and Ecosystems Monitoring and Management (wetlands)	P2/C2
30	**INRMP annual and 5-year updates:** Continue to update Navy metrics builder, meet with INRMP Working Group Members, and update document as required.	Natural Resources Studies	P2/C2
31	**Update/initiate installation-wide flora and fauna mapping:** The Navy will update flora and fauna surveys and mapping at all sites (Sections 4.3.3, 4.3.5) in order to protect, conserve, and manage plant and animal species and expand database on potential listed species in preparation for subsequent INRMP updates. Botanical surveys will also include early detection for species of concern that may be new to Leeward O'ahu or species that may be new to the island. Findings will be shared with the O'ahu Invasive Species Committee (OISC) so that OISC can conduct delimiting surveys on lands bordering Navy property if necessary. Bird surveys will include discussion and recommendations for habitat restoration opportunities. Aerial imaging for landscape scale vegetation mapping should be done in Lualualei to include areas of Christmas berry forest, other invasive vegetation types, and stands of native forest. High resolution aerial imaging can be used to measure changes in vegetation type due to continued invasion or through landscape restoration. These data can provide better estimates of landscape scale restoration costing. Mapping and status assessments can be done during site visits scheduled for invasive vegetation control. Both ground and aerial mapping can be linked to a geodatabase.	Natural Resources Studies	P2/C2
32	**Dryland forest restoration studies:** Dryland forest restoration techniques have been poorly developed in Hawaii. Given the heavy degradation of dryland forests on O'ahu from invasive species, re-engineering these ecosystems requires significant research on large scale invasive species removal and revegetation techniques. This type of research should be coordinated with off-site researchers at the University of Hawai'i or through the Legacy Funding Program (Section 9.8).	Natural Resources Studies	P3/C3
33	**Natural resources GIS data management:** JBPHH will continue to manage, integrate, access and report natural resources GIS data into JBPHH GIS database (Section 2.4), with major inputs anticipated during 5-year floral/faunal survey updates associated with INRMP revisions. GIS data will also be continually uploaded into RSIMS for early planning by facilities managers	GIS	P2/CL2
34	**Develop a GIS layer for mature and significant trees and landscapes:** The Navy will develop a GPS-based GIS map layer indicating the location of known mature and significant trees and landscapes that could be included in CNRH's geodatabase (Section 3.4.4).	GIS	P3/C3

Table 9-3: Recommended Management Actions for Lualualei (Continued)

Item No.	Recommendation	Management Action	Funding
35	**Protect mature and significant trees, landscapes, and pocket forests:** Facility managers from JBPHH will be required to get approval from the JBPHH XO prior to removing any tree within the installation (Section 3.4.4). Species of trees that are invasive would not be protected. In cases where the tree provides an important function (shade, for example) replacement with a non-invasive tree will be considered. JBPHH will prepare an instruction for this requirement.	Forestry	P2/NOC
36	**Continue standard provisions in construction/landscape contracts:** Continue to include standard provisions in all construction and landscape contracts regarding procedures to follow when working near mature and/or significant trees and landscapes (Section 3.4.4). Contract landscapers will also be instructed to plant non-invasive species when choosing plants for ornamental purposes. Species can be checked for potential high risk at www.wra.org or hpwra@yahoo.com.	Forestry/Land Management	P2/NOC
37	**Promote awareness of ESA- and other protected species and natural resources stewardship:** The Navy will continue to promote awareness of ESA- and other protected species and natural resources stewardship among JBPHH personnel and residents through on-going educational efforts such as printed material in "Welcome Aboard" packet, signs in ecologically sensitive areas (e.g., wetlands, forests), promotion of community service projects, and brochures at selected locations	Community Outreach	P3/NOC
38	**Base planning:** A routine procedure will continue to be implemented to assure coordination among facilities planners, resource managers, SOH, and county officials (Section 4.4.7). The NAVFAC HI Natural Resources Manager will continue to be the point of contact to provide relevant information on issues with the potential to affect waterbirds, such as sound levels, direct habitat loss due to clearance and construction, proximity to neighboring habitats, and sensitivity of the birds to disturbance. Natural resources surveys may be required and mitigation measures developed to assure protection of federally-listed threatened and endangered or otherwise protected species and their habitats.	Land Management	P2/NOC
39	**Landscape design:** The JBPHH IEPM will continue to evaluate all future landscape design and installation projects for the potential to include habitat restoration and the use of native plants whenever possible. The preference for native plant materials from O'ahu, as well as the importance of using sterile soil to prevent the introduction of pests such as nematodes, will continue to be emphasized. When choosing plants for landscape design, landscapers will consult the Weed Risk Assessment (WRA) (www.hear.org/wra) to ensure the species area not potentially invasive. The WRA analyzes a species' biology and history in Hawai'i to determine if it poses a high risk of becoming invasive. Species not listed on the website can be assessed for potential high risk by contacting hpwra@yahoo.com.	Land Management	P2/NOC
40	**Prevention of point source pollution:** The Navy will continue the current policy of pollution reduction for JBPHH, including the identification of sources of pollutants in the harbor and their reduction/elimination (Section 4.4.7).	Land Management	P2/NOC
41	**Soil stabilization and erosion control:** The Navy will continue to utilize BMPs during earthwork, construction, and the design of storm drainage systems (Section 4.4.7).	Land Management	P2/NOC

Table 9-3: Recommended Management Actions for Lualualei (Continued)

Item No.	Recommendation	Management Action	Funding
42	**Law enforcement:** A conservation officer will be hired to enforce natural resources and other environmental compliance-related laws, regulations, and instructions.	Law Enforcement	P2/C2
43	**Continue FFD and/or HFD response to any wildland fires:** Any wildland fires at all JBPHH facilities will continue to be addressed by the appropriate fire departments (Section 4.4.10). The Federal Fire Department at Lualualei would continue to coordinate with the O'ahu Wildland Fire Council to ensure that fuel breaks, water sources, fire prevention measures, and fire suppression staffing are adequate are adequate to ensure the activities at the Lualualei INRMP study area minimize potential for wildland fire impacts to listed species. A wildland fire management plan is to be developed so that all stakeholders understand their respective roles and responsibilities, and a rapid coordinated response can be assured. This management plan should be coordinated on by the Wai'anae Mountain Watershed Partnership.	Wildland Fire	P2/NOC/ C2
44	**Monitor off-site development:** The Navy will continue to monitor adjacent, off-site development for compatibility at all sites (Sections 3.4.11, 4.4.11, and 5.4.11).	Wildland Fire	P2/NOC
45	**Agricultural outleases:** The Navy will explore maintaining and/or increasing outlease opportunities, at Lualualei. Water resources are particularly limited along the Wai'anae coast, and intensive row-cropping at Lualualei will likely require community partnerships and dialogue to ensure equitable water partitioning. Moreover, an analysis of the water table and the importance of a high-water table to the permanent and intermittent streams at Lualualei will need to be explored. Outleases for native plant production are compatible with open, degraded areas at Lualualei.	Leases and Encroachment Management	P2/NOC

9.3.3 NCTAMSPAC Wahiawa Proposed Actions

Table 9-4 provides a summary of the recommended management actions for JBPHH's NCTAMSPAC Wahiawa Study Area. These recommended actions along with their 10-year fiscal plan are listed in Table 9-8 (end of the chapter).

Table 9-4: Recommended Management Actions for NCTAMSPAC Wahiawa

Item No.	Recommendation	Management Action	Funding
1	**Regulatory agency coordination**: In accordance with EO 13352, the JBPHH IEPM, NAVFAC PAC Natural Resources staff, and the CNRH Natural Resource Program Manager will continue to coordinate with federal and SOH agencies on natural resources issues pertaining to threatened and endangered species, critical habitat, species of concern, MBTA bird species, invasive species, and update to the next INRMP.	Protected Species and Ecosystems Monitoring and Management	P2/ NOC
2	**Protected bird species management, monitoring, and reporting:** Management actions described in Section 5.4.1.1 for Hawaiian short-eared owls and MBTA-protected bird species will be continued in addition to other projects described below. These include population monitoring, appropriate resource agency coordination, maintaining and updating cooperative agreements and SOPs, and conducting project reviews and consultations that may affect listed bird species.	Protected Species and Ecosystems Monitoring and Management	P2/C2
3	**Hawaiian bat acoustic surveys:** The USGS has developed a standardized detection protocol for Hawaiian hoary bats using an acoustic detection unit. These units are mounted in the field for several days to a month and record presence or absence and frequency of bat calls. These surveys should be conducted at NCTAMS PAC Wahiawa.	Protected Species and Ecosystems Monitoring and Management	P2/C2
4	**Provide staff focused, annual natural resources training:** The Navy will provide focused annual training for JBPHH Environmental Storefront Coordinators in order to improve and enhance programs for endangered species protection and invasive species detection. Training and outreach materials will include Hawai'i Department of Agriculture's pest hotline (643-PEST). This number can be used to report snakes, red imported fire ant, coqui frog, invasive plants and other suspicious creatures. In addition, training will include coqui frog identification materials.	Protected Species and Ecosystems Monitoring and Management (natural resources awareness)	P2/C2
5	**Maintain security restrictions:** Access to NCTAMSPAC Wahiawa is generally restricted to base residents and employees which provides a measure of protection to the habitat where the Hawaiian short-eared owl (SOH-listed endangered [on O'ahu] bird species) may occur.	Protected Species and Ecosystems Monitoring and Management (access restrictions)	P2/NOC
6	**Hunting to control feral ungulates:** The Navy will initiate a restricted-access public hunting program to control feral ungulates in order to protect, conserve, and manage native species at NCTAMSPAC Wahiawa.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2

Table 9-4: Recommended Management Actions for NCTAMSPAC Wahiawa (Continued)

Item No.	Recommendation	Management Action	Funding
7	**Invasive species biosecurity SOPs:** The Navy will update SOPs for personnel training and provide natural resources information to personnel relocating to JBPHH. The Navy will continue to require decontamination (cleaning) of all vehicles, equipment, personal gear, shoes, and clothing before personnel may enter a training area at PHNC in order to minimize the introduction of invasive species. The JBPHH IEPM will provide information about invasive species to be included in "Welcome Aboard" packages for incoming Navy personnel. Natural resources information includes the effects of alien plant and animal species to native ecosystems and federally-listed threatened and endangered or otherwise protected species.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
8	**Control alien plants:** The NAVFAC HI Natural Resources Program Manager will continue to evaluate and prioritize invasive noxious plants to be controlled, with emphasis on newly emerging weeds or those species or populations encroaching on healthy native plant populations and habitats. The prevention and control of weed populations will continue to be incorporated into written updates to the INRMP.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
9	**Early detection roadside surveys:** The O'ahu Early Detection Program conducts roadside surveys of military installations in search of incipient invasive plants. This program is funded by the State Invasive Species Committees, and is operated out of the Bishop Museum. This program can be supported by providing access to program personnel on a regular basis (annually or less frequently).	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
10	**Revegetation with native plants:** Restored and intact native habitats provide vital ecosystem services such as clean water, topsoil retention, and nesting and foraging areas for native species. When practicable, native species from O'ahu (preferably JBPHH installations) will be used in landscaping, replanting, site recovery, and other conservation efforts. The JBPHH IEPM may promote participation with interested parties.	Protected Species and Ecosystems Monitoring and Management (natural resource restoration)	P2/C2
11	**Wetlands management:** The Navy will continue its wetlands management policies described in Section 3.4.1.6. These include protecting wetlands from dredging, filling, or otherwise destroying without proper permits and necessary minimization and mitigative measures (i.e., no net loss of wetlands). In addition, the Navy will coordinate any wetland enhancement efforts with appropriate federal and SOH agencies. The Navy will continue to promote wetlands mitigation banking. The Navy will continue to ensure that planning staff receive formal, annual training on wetlands regulations and policy in order to properly identify, manage, and protect installation wetlands in accordance with "no net loss of wetlands" values.	Protected Species and Ecosystems Monitoring and Management (wetlands)	P2/NOC
12	**INRMP annual and 5-year updates:** The Navy will continue to update Navy metrics builder, meet with INRMP Working Group Members, and update document as required.	Natural Resources Studies	P2/C2

Table 9-4: Recommended Management Actions for NCTAMSPAC Wahiawa (Continued)

Item No.	Recommendation	Management Action	Funding
13	**Update/initiate flora and fauna mapping:** The Navy will update flora and fauna surveys and mapping at all sites (Sections 5.3.3, 5.3.5) in order to protect, conserve, and manage plant and animal species and expand database on potential listed species at all installations and in preparation for subsequent INRMP updates. The JBPHH IEPM will continue to coordinate with DLNR-DOFAW and DAR as well as USFWS to collect population-monitoring data for protected species. Population monitoring data will continue to be evaluated for any necessary changes or improvements in management actions. Botanical surveys will also include early detection for species of concern that may be new to Leeward O'ahu or species that may be new to the island. Findings will be shared with the O'ahu Invasive Species Committee (OISC) so that OISC can conduct delimiting surveys on lands bordering Navy property if necessary. Bird surveys will include discussion and recommendations for habitat restoration opportunities.	Natural Resources Studies	P2/C2
14	**Natural resource GIS data management:** JBPHH will continue to manage, integrate, access, and report natural resources GIS data into JBPHH GIS database (Section 2.4), with major inputs anticipated during 5-year floral/faunal survey updates associated with INRMP revisions. GIS data will also be continually uploaded into RSIMS for early planning by facilities managers	GIS	P2/C2
15	**Develop a GIS layer for mature and significant trees and landscapes:** The Navy will develop a GPS-based GIS map layer indicating the location of known mature and significant trees and landscapes that could be included in CNRH's geodatabase (Section 3.4.4).	GIS/Forestry	P3/C3
16	**Protect mature and significant trees, landscapes, and pocket forests:** Facility managers from JBPHH will be required to get approval from the JBPHH XO prior to removing any tree within the installation (Section 3.4.4). Species of trees that are invasive would not be protected. In cases where the tree provides an important function (shade, for example) replacement with a non-invasive tree will be considered. JBPHH will prepare an instruction for this requirement.	Forestry/Land Management	P2/NOC
17	**Continue standard provisions in construction/landscape contracts:** Continue to include standard provisions in all construction and landscape contracts regarding procedures to follow when working near mature and/or significant trees and landscapes (Section 3.4.4). Contract landscapers will also be instructed to plant non-invasive species when choosing plants for ornamental purposes. Species can be checked for potential high risk at www.wra.org or hpwra@yahoo.com.	Forestry/Land Management	P2/NOC
18	**Promote awareness of ESA- and other protected species and natural resources stewardship:** The Navy will continue to promote awareness of ESA- and other protected species and natural resources stewardship among JBPHH personnel and residents through on-going educational efforts such as printed material in "Welcome Aboard" packet, signs in ecologically sensitive areas (e.g., wetlands, forests), promotion of community service projects, and brochures selected locations. The Navy will create a specific educational plan to alert residents/personnel about the impacts of feral cat and dog populations on native wildlife.	Community Outreach	P3/C3
19	**Continue to support jogging, walking, hiking:** The Navy will continue to support jogging, walking, hiking along NCTAMSPAC Wahiawa perimeter trail in order to enhance outdoor recreational opportunities for installation personnel and residents.	Outdoor Recreation	P3/C3

Table 9-4: Recommended Management Actions for NCTAMSPAC Wahiawa (Continued)

Item No.	Recommendation	Management Action	Funding
20	**Base planning:** A routine procedure will continue to be implemented to assure coordination among facilities planners, resource managers, SOH, and county officials (Section 5.4.7). The NAVFAC HI Natural Resources Manager will continue to be the point of contact to provide relevant information on issues with potential to affect waterbirds, such as sound levels, direct habitat loss due to clearance and construction, proximity to neighboring habitats, and sensitivity of the birds to disturbance. Natural resources surveys may be required and mitigation measures developed to assure protection of federally-listed threatened and endangered or otherwise protected species and their habitats.	Land Management	P2/NOC
21	**Landscape design:** The JBPHH IEPM will continue to evaluate all future landscape design and installation projects for the potential to include habitat restoration and the use of native plants whenever possible. The preference for native plant materials from O'ahu, as well as the importance of using sterile soil to prevent the introduction of pests such as nematodes, will continue to be emphasized. When choosing plants for landscape design, landscapers will consult the Weed Risk Assessment (WRA) (www.hear.org/wra) to ensure the species area not potentially invasive. The WRA analyzes a species' biology and history in Hawai'i to determine if it poses a high risk of becoming invasive. Species not listed on the website can be assessed for potential high risk by contacting hpwra@yahoo.com.	Land Management	P2/NOC
22	**Prevention of point source pollution:** The Navy will continue the current policy of pollution reduction for JBPHH, including the identification of sources of pollutants in the harbor and their reduction/elimination (Section 5.4.7).	Land Management	P2/NOC
23	**Soil stabilization and erosion control:** The Navy will continue to utilize BMPs during earthwork, construction, and the design of storm drainage systems (Section 5.4.7).	Land Management	P2/NOC
24	**Law enforcement:** A conservation officer will be hired to enforce natural resources and other environmental compliance-related laws, regulations, and instructions.	Law Enforcement	P2/NOC/C2
25	**Continue FFD and/or HFD response to any wildland fires:** Any wildland fires at all JBPHH facilities will continue to be addressed by the appropriate fire departments (Section 5.4.10).	Wildland Fire	P2/NOC
26	**Monitor off-site development:** The Navy will continue to monitor adjacent, off-site development for compatibility at all sites (Section 5.4.11).	Leases and Encroachment Management	P2/NOC

9.3.4 Kalaeloa Proposed Actions

Table 9-5 provides a summary of the recommended management actions for JBPHH's Kalaeloa Study Area. These recommended actions along with their 10-year fiscal plan are listed in Table 9-9 (end of the chapter).

Table 9-5: Recommended Management Actions for Kalaeloa

Item No.	Recommendation	Management Action	Funding
1	**Regulatory agency coordination**: In accordance with EO 13352, the JBPHH IEPM, NAVFAC PAC Natural Resources staff, and the CNRH Natural Resource Program Manager will continue to coordinate with federal and SOH agencies on natural resources issues pertaining to threatened and endangered species, critical habitat, species of concern, MBTA bird species, invasive species, and the update of the next INRMP.	Protected Species and Ecosystems Monitoring and Management	P2/ NOC
2	**Protected bird species management, monitoring, and reporting:** Management actions described in Section 6.4.1.1 for Hawaiian waterbirds, Hawaiian short-eared owls, and MBTA-protected bird species will be continued in addition to other projects described below. These include population monitoring, appropriate resource agency coordination, maintaining and updating cooperative agreements and SOPs, and conducting project reviews and consultations that may affect listed bird species.	Protected Species and Ecosystems Monitoring and Management	P2/C2
3	**Hawaiian monk seal monitoring and protection:** JBPHH personnel will employ a number of SOPs and management actions in order to protect monk seals that haul out on the beach or are observed injured or struggling in nearshore waters. The Navy will upgrade the management actions discussed in Section 3.4.1.1, Section 6.4.1.1, and summarized below. • JBPHH environmental personnel will maintain their training and contacts with NOAA's Marine Mammal Stranding Network to execute a quick response to any beaching or entanglement events on JBPHH beaches or nearshore waters. Coordination with NOAA Fisheries for any associated necropsies, if required, will also be ensured. • JBPHH personnel, working with DLNR monk seal volunteers, will record all sightings of monk seals and report tag numbers to NOAA Fisheries. To ensure protection from disturbance, any animals hauled up on the beach within the public use area will be cordoned off by security forces and reported to JBPHH IEPM. • JBPHH will continue to restrict recreational shore fishing to designated areas in order to reduce the probability of entanglement with stray fishing line while still providing some recreational opportunities, and to promote healthy nearshore reef-fish stocks. • JBPHH will continue to restrict dogs off leashes along the beach to limit the potential for seal-dog interactions. • JBPHH will continue to control feral animals (dogs) on base that can transfer diseases to monk seals. • The Navy will continue to ensure training activities do not affect hauled-out seals at JBPHH beaches. Prior to conducting a beach landing exercises, Navy observers will survey beaches for Hawaiian monk seals. Should a monk seal be found on the beach, the landing will be delayed until the animal has voluntarily left the area. • JBPHH will continue to sponsor marine debris clean up events.	Protected Species and Ecosystems Monitoring and Management	P2/ NOC/C2
4	**Maintain/update SOPs for the protection of ESA-protected species:** The Navy will continue to update SOPs (Appendix I) with regard to ESA-protected species (Section 6.3.1). These SOPs instruct Navy personnel in how to respond to situations involving ESA-protected species that are known to occur at JBPHH.	Protected Species and Ecosystems Monitoring and Management	P2/C2

Table 9-5: Recommended Management Actions for Kalaeloa (Continued)

Item No.	Recommendation	Management Action	Funding
5	**Protection of rare and/or protected species during training**: All Navy training activities at Kalaeloa will be performed in accordance with all applicable biological opinions and existing USCG regulations. Areas known to contain protected species including 'akoko shrub and round-leafed chaff flower will continue to be avoided during Navy training exercises at Kalaeloa. Any potential impacts to listed bird species such as the Hawaiian stilt will be addressed through coordination and/or consultation with USFWS. The Navy will continue to require that established procedures are followed during amphibious crew inserts. These include having designated look outs watching for other vessels, obstructions to navigation, marine mammals including whales and monk seals, and sea turtles. Personnel will continue to be required to review training overlays that identify the insertion points and any nearby restricted areas. All sensitive biological receptors will be avoided by personnel. The Navy will continue to prohibit bivouacking of personnel within 3,280 ft (1,000 m) of posted signs marking the presence of rare and/or protected plant and animal species or restoration projects. No training units larger than 30 personnel (platoon size) will be allowed to bivouac outside of reusable bivouac sites provided with portable or reusable latrines. No open fires, burying or leaving of trash, food preparation, cutting, or clearing of vegetation, or disturbing of vegetation including mosses, grasses, shrubs, bushes, and trees will be allowed during bivouacking.	Protected Species and Ecosystems Monitoring and Management	P2/NOC
6	**Marine debris reduction**: The Navy will continue to seek ways to reduce the amount of waste generated by its afloat forces. Many Navy ships will continue to meet or exceed existing legal requirements regarding waste management. Navy ships will continue to retain all plastics on board, melting and compressing the accumulated materials for land-based recycling or disposal. Navy members will continue to routinely remove marine debris from Pearl Harbor and PHEC and will continue to work in partnership with other agencies in removing derelict fishing gear caught on the ocean floor in NWHI.	Protected Species and Ecosystems Monitoring and Management	P2/NOC
7	**Kalaeloa' akoko management:** The Navy will restrict access to the 'akoko plants until the transfer of Lot 58-D is complete. In addition, the Navy will support volunteer efforts to weed around the 'akoko plants at Kalaeloa.	Protected Species and Ecosystems Monitoring and Management	P2/C2
8	**Provide staff focused, annual natural resources training:** The Navy will provide focused annual training for JBPHH Environmental Storefront Coordinators in order to improve and enhance programs for land/habitat improvements and rehabilitation. Training and outreach materials will include Hawai'i Department of Agriculture's pest hotline (643-PEST). This number can be used to report snakes, red imported fire ant, coqui frog, invasive plants and other suspicious creatures. In addition, training will include coqui frog identification materials.	Protected Species and Ecosystems Monitoring and Management (natural resources awareness)	P2/C2
9	**Fencing and signage used to mark presence of rare and/or protected species:** The Navy will continue to maintain signs and fences to prohibit personnel in areas with rare and/or protected species (Section 6.4.1.2).	Protected Species and Ecosystems Monitoring and Management (access restrictions)	P2/C2
10	**Access restrictions:** The Navy will continue access restrictions at Lot 58-D and at Lot 73-A. These restrictions provide a measure of protection for the protected species at these sites (i.e., 'akoko and Hawaiian black-necked stilt).	Protected Species and Ecosystems Monitoring and Management (access restrictions)	P2/NOC

Table 9-5: Recommended Management Actions for Kalaeloa (Continued)

Item No.	Recommendation	Management Action	Funding
11	**Predator control at Nimitz and White Plains beaches**: The Navy will initiate predator control around beach areas at Kalaeloa, focusing on dogs and feral/stray cats.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
12	**Invasive species biosecurity SOPs:** The Navy will update SOPs for personnel training and provide natural resources information to personnel relocating to JBPHH. The Navy will continue to require decontamination (cleaning) of all vehicles, equipment, personal gear, shoes, and clothing before personnel may enter a training area at PHNC in order to minimize the introduction of invasive species. The JBPHH IEPM will provide information about invasive species to be included in "Welcome Aboard" packages for incoming Navy personnel. Natural resources information includes the effects of alien plant and animal species to native ecosystems and federally-listed threatened and endangered or otherwise protected species.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
13	**Control alien plants:** The JBPHH IEPM will continue to evaluate and prioritize invasive noxious plants to be controlled with emphasis on newly emerging weeds or those species or populations encroaching on healthy native plant populations and habitats. The prevention and control of weed populations will continue to be incorporated into a written updates to the INRMP.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
14	**Early detection roadside surveys:** The O'ahu Early Detection Program conducts roadside surveys of military installations in search of incipient invasive plants. This program is funded by the State Invasive Species Committees, and is operated out of the Bishop Museum. This program can be supported by providing access to program personnel on a regular basis (annually or less frequently).	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
15	**Revegetation with native plants:** Restored and intact native habitats provide vital ecosystem services such as clean water, topsoil retention, and nesting and foraging areas for native species. When practicable, native species from O'ahu (preferably JBPHH installations) will be used in landscaping, replanting, recovery, and other conservation efforts. The JBPHH IEPM may promote participation with interested parties.	Protected Species and Ecosystems Monitoring and Management (natural resources restoration)	P2/C2
16	**Wetlands management:** The Navy will continue its wetlands management policies described in Section 3.4.1.6. These policies include protecting wetlands from dredging, filling, or otherwise destroying without proper permits and necessary minimization and mitigative measures (i.e., no net loss of wetlands). In addition, the Navy will coordinate any wetland enhancement efforts with appropriate federal and SOH agencies. The Navy will continue to promote wetlands mitigation banking. The Navy will continue to ensure that planning staff receive formal, annual training on wetlands regulations and policy in order to properly identify, manage, and protect installation wetlands in accordance with "no net loss of wetlands" values.	Protected Species and Ecosystems Monitoring and Management (wetlands)	P2/NOC
17	**INRMP annual and 5-year updates:** Continue to update Navy metrics builder, meet with INRMP Working Group Members, and update document as required	Natural Resources Studies	P2/C2

Table 9-5: Recommended Management Actions for Kalaeloa (Continued)

Item No.	Recommendation	Management Action	Funding
18	**Update/initiate flora and fauna mapping:** The Navy will update flora and fauna surveys and mapping at all sites (Sections 6.3.3, 6.3.5) in order to protect, conserve, and manage plant and animal species and expand database on potential listed species at all installations and in preparation for subsequent INRMP updates. The NAVFAC HI Natural Resources Manager will continue to coordinate with DLNR-DOFAW on the status of population-monitoring data for protected species. Population monitoring data will continue to be evaluated for any necessary changes or improvements in management actions. Botanical surveys will also include early detection for species of concern that may be new to Leeward O'ahu or species that may be new to the island. Findings will be shared with the O'ahu Invasive Species Committee (OISC) so that OISC can conduct delimiting surveys on lands bordering Navy property if necessary. Bird surveys will include discussion and recommendations for habitat restoration opportunities.	Natural Resources Studies	P2/C2
19	**Natural resource GIS data management:** JBPHH will continue to manage, integrate, access, and report natural resources GIS data into JBPHH GIS database (Section 2.4), with major inputs anticipated during 5-year floral/faunal survey updates associated with INRMP revisions. GIS data will also be continually uploaded into RSIMS for early planning by facilities managers	GIS	P2/C2
20	**Develop a GIS layer for mature and significant trees and landscapes:** The Navy will develop a GPS-based GIS map layer indicating the location of known mature and significant trees and landscapes that could be included in CNRH's geodatabase (Section 3.4.4).	GIS/Forestry	P3/C3
21	**Protect mature and significant trees, landscapes, and pocket forests:** Facility managers from JBPHH will be required to get approval from the JBPHH XO prior to removing any tree within the installation (Section 3.4.4). Species of trees that are invasive would not be protected. In cases where the tree provides an important function (shade, for example) replacement with a non-invasive tree will be considered. JBPHH will prepare an instruction for this requirement.	Forestry/Land Management	P2/NOC
22	**Continue standard provisions in construction/landscape contracts:** Continue to include standard provisions in all construction and landscape contracts regarding procedures to follow when working near mature and/or significant trees and landscapes (Section 3.4.4). Contract landscapers will also be instructed to plant non-invasive species when choosing plants for ornamental purposes. Species can be checked for potential high risk at www.wra.org or hpwra@yahoo.com.	Forestry/Land Management	P2/NOC
23	**Promote awareness of ESA- and other protected species and natural resources stewardship:** The Navy will continue to promote awareness of ESA- and other protected species and natural resources stewardship among JBPHH personnel and residents through on-going educational efforts such as printed material in "Welcome Aboard" packet, signs in ecologically sensitive areas (e.g., wetlands, forests), promotion of community service projects and beach cleanups, and brochures selected locations.	Community Outreach	P3/C3
24	**Continue to promote public outdoor recreation events:** The Navy will continue to promote public events at Kalaeloa including surfing competitions.	Outdoor Recreation	P3/NOC
25	**Continue to promote swimming, surfing, body boarding, jogging, bicycling, and picnicking:** MWR will continue to promote swimming, surfing, body boarding, jogging, bicycling, and picnicking at White Plains Beach and Nimitz Beach (6.4.6).	Outdoor Recreation	P3/NOC

Table 9-5: Recommended Management Actions for Kalaeloa (Continued)

Item No.	Recommendation	Management Action	Funding
26	**Base planning:** A routine procedure will continue to be implemented to assure coordination among facilities planners, resource managers, SOH, and county officials (Section 6.4.7). The JBPHH IEPM will continue to be the point of contact to provide relevant information on issues with potential to affect waterbirds, such as sound levels, direct habitat loss due to clearance and construction, proximity to neighboring habitats, and sensitivity of the birds to disturbance. Natural resources surveys may be required and mitigation measures developed to assure protection of federally-listed, threatened and endangered or otherwise protected species and their habitats.	Land Management	P2/NOC
27	**Landscape design:** The JBPHH IEPM will continue to evaluate all future landscape design and installation projects for the potential to include habitat restoration and the use of native plants whenever possible. The preference for native plant materials from O'ahu, as well as the importance of using sterile soil to prevent the introduction of pests such as nematodes, will continue to be emphasized. When choosing plants for landscape design, landscapers will consult the Weed Risk Assessment (WRA) (www.hear.org/wra) to ensure the species area not potentially invasive. The WRA analyzes a species' biology and history in Hawai'i to determine if it poses a high risk of becoming invasive. Species not listed on the website can be assessed for potential high risk by contacting hpwra@yahoo.com.	Land Management	P2/NOC
28	**Prevention of point source pollution:** The Navy will continue the current policy of pollution reduction for JBPHH, including the identification of sources of pollutants in the harbor and their reduction/elimination (Section 6.4.7).	Land Management	P2/NOC
29	**Soil stabilization and erosion control:** The Navy will continue to utilize BMPs during earthwork, construction, and the design of storm drainage systems (Section 6.4.7)	Land Management	P2/NOC
30	**Land management restrictions during training maneuvers:** The Navy will continue to prohibit vehicle traffic off existing roads, use of rocks from rock piles or walls for training purposes, and establishment of new vehicle tracks during training maneuvers. In addition, during personnel maneuvers, digging, including entrenchments and foxholes, will continue to be prohibited, except in areas specifically designated by the training coordinator. No new placement of barbed wire or concertina wire near signs marking the presence of sensitive ecological areas or fences will be allowed by personnel during maneuvers. No road, trail, or fire break clearing will be allowed during trainer maneuvers without permission from training coordinator. No grading or construction of buildings or other permanent structures will be allowed without permission from the training coordinator (Section 6.4.7).	Land Management	P2/NOC
31	**Floodplains:** The majority of the JBPHH lands are not within documented floodplains. Nimitz Beach and White Plains Beach, located on Navy-retained lands at Kalaeloa, are both located within the 100-year coast flood hazard area. CCH maintains a civil defense siren system within the Kalaeloa District which would alert beach goers in the event of tsunami warning or threat.	Floodplains	P2/NOC
32	**Law enforcement:** A conservation officer will be hired to enforce natural resources and other environmental compliance-related laws, regulations, and instructions	Law Enforcement	P2/C2
33	**Continue FFD and/or HFD response to any wildland fires:** Any wildland fires at all JBPHH facilities will continue to be addressed by the appropriate fire departments (Section 6.4.10).	Wildland Fire	P2/NOC

Table 9-5: Recommended Management Actions for Kalaeloa (Continued)

Item No.	Recommendation	Management Action	Funding
34	**Emergency fire fighting by personnel during training exercises:** In case of fire during personnel training exercises, all fires will be reported to the FFD and personnel will stop training and begin to fight the fire. Personnel will continue to fight the fire until released by the fire department (Section 6.4.10)	Wildland Fire	P2/NOC

9.3.5 Hickam Proposed Actions

Table 9-6 provides a summary of the recommended management actions for JBPHH's Hickam Study Area. These recommended actions along with their 10-year fiscal plan are listed in Table 9-8 (end of the chapter).

Table 9-6: Recommended Management Actions for Hickam

Item No.	Recommendation	Management Action	Funding
1	**Regulatory agency coordination**: In accordance with EO 13352 (Section 2.8), the JBPHH IEPM, NAVFAC PAC Natural Resources staff, and the CNRH Natural Resource Program Manager will continue to coordinate with federal and SOH agencies on natural resources issues pertaining to threatened and endangered species, critical habitat, species of concern, MBTA bird species, and invasive species.	Protected Species and Ecosystems Monitoring and Management	P2/ NOC
2	**Protected bird species management, monitoring, and reporting.** Management actions described in Section 3.4.1.1 for Hawaiian waterbirds, white terns, Hawaiian short-eared owls, and MBTA-protected bird species will be continued in addition to other projects described below. These include population monitoring and supporting the DLNR bi-annual waterbird survey, appropriate resource agency coordination, maintaining and updating cooperative agreements and SOPs, and conducting project reviews and consultations that may affect listed bird species.	Protected Species and Ecosystems Monitoring and Management	P2/C2
3	**BASH support for Hickam Airfield:** The Navy will support Air Force airfield operations by assisting airfield managers with compliance of provisions of the Biological Opinion (Appendix H) and providing recommendations to reduce risks of bird strikes	Protected Species and Ecosystems Monitoring and Management	P2/C2
4	**Hawaiian waterbird banding and resighting study**: This project is to track movements of Hawaiian Stilts across the south shore of O'ahu using radio tags and/or bands. The purpose of this project is to better understand the behavior of the stilt, their utilization of Hickam AFB, and risk of BASH. This project may be conducted cooperatively by the USAF, USFWS, DLNR and the University of Hawaii. This approach could include cost sharing which could result in expanded project scope and reduced cost for each participating group. Application for state and/or federal grants should be considered.	Protected Species and Ecosystems Monitoring and Management	P2/C2

Table 9-6: Recommended Management Actions for Hickam (Continued)

Item No.	Recommendation	Management Action	Funding
5	**Hawaiian monk seal monitoring and protection:** JBPHH personnel will employ a number of SOPs and management actions in order to protect monk seals that haul out on the beach or are observed injured or struggling in nearshore waters. The Navy will upgrade the management actions discussed in Section 3.4.1.1 and summarized below. • JBPHH environmental personnel will maintain their training and contacts with NOAA's Marine Mammal Stranding Network to execute a quick response to any beaching or entanglement events on JBPHH beaches or nearshore waters. Coordination with NOAA Fisheries for any associated necropsies, if required, will also be ensured. • JBPHH personnel will record all sightings of monk seals and report tag numbers to NOAA Fisheries. To ensure protection from disturbance, any animals hauled up on the beach within the public use area will be cordoned off by security forces and reported to JBPHH IEPM. • JBPHH will continue to restrict recreational shore fishing to designated areas in order to reduce the probability of entanglement with stray fishing line while still providing some recreational opportunities, and to promote healthy nearshore reef-fish stocks. • JBPHH will continue to restrict dogs off leashes along the beach to limit the potential for seal-dog interactions. • JBPHH will continue to control feral animals (dogs) on base that can transfer diseases to monk seals. • The Navy will continue to ensure training activities do not affect hauled-out seals at JBPHH beaches. Prior to conducting a beach landing exercises, Navy observers will survey beaches for Hawaiian monk seals. Should a monk seal be found on the beach, the landing will be delayed until the animal has voluntarily left the area. • JBPHH will continue to sponsor marine debris clean up events.	Protected Species and Ecosystems Monitoring and Management	P2/NOC/C2
6	**Maintain/update SOPs for the protection of MBTA and ESA-protected species:** The Navy will continue to update SOPs (Appendix I) with regard to ESA-protected species). These SOPs instruct Navy personnel in how to respond to situations involving protected species that are known to occur at Hickam.	Protected Species and Ecosystems Monitoring and Management	P2/C2
7	**Provide staff focused, annual natural resources training:** The Navy will provide focused annual training for JBPHH Environmental Storefront Coordinators in order to improve and enhance programs endangered species protection and invasive species detection. Training and outreach materials will include Hawai'i Department of Agriculture's pest hotline (808.643-PEST). This number can be used to report snakes, red imported fire ant, coqui frog, invasive plants and other suspicious creatures. In addition, training will include coqui frog identification materials.	Protected Species and Ecosystems Monitoring and Management (natural resources awareness)	P2/C2
8	**Āhua Reef cleanup**: Annual clean up of marine debris at Āhua Reef provides an outreach opportunity and a conservation benefit to marine species such as green turtles and Hawaiian monk seals.	Protected Species and Ecosystems Monitoring and Management (natural resources restoration)	P2/C2
9	**Mangrove removal:** In compliance with conditions of the BO, mangroves will continue to be removed at Āhua Reef. Mangroves along the conveyance canals and golf-course shoreline are not conservation actions listed in the BO, and their removal will be a secondary priority, and should be coordinated closely with facilities who may jointly fund the project.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2

Table 9-6: Recommended Management Actions for Hickam (Continued)

Item No.	Recommendation	Management Action	Funding
10	**Predator control:** The purpose of this project is to reduce predation on native species by exotic species such as mongoose, feral cats and dogs using a trapping and hunting program. Note: Hunting by the public will not be permitted at Hickam, but can be conducted by natural resource management personnel or their contractors hired for the specific purpose of predator removal. This has typically been executed by USDA Wildlife Services.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
11	**Exotic fish eradication**: The purpose of this project is to eliminate exotic fish species from the streams and canals on Hickam AFB. An initial feasibility study is to be conducted with the guidance of SOH DLNR Division of Aquatic Resources	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
12	**Hickam biosecurity plan:** An inspection program for cargo being loaded for shipment and cargo being received, from U.S. ports, Guam, or overseas, is to be initiated. Currently, only overseas cargo is inspected. Key items to search for include live plants, soil, snakes, rodents, or arthropod-infested goods. A biosecurity plan should be coordinated with other Navy and Air Force installations to ensure efficiencies in inspection plan development. The biosecurity plan also calls for the maintenance of a high level of cleanliness at shipping and receiving ports at Hickam.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
13	**Invasive species biosecurity SOPs:** The Navy will update SOPs for personnel training and provide natural resources information to personnel relocating to JBPHH. The Navy will continue to require decontamination (cleaning) of all vehicles, equipment, personal gear, shoes, and clothing before personnel may enter a training area at PHNC in order to minimize the introduction of invasive species. The JBPHH IEPM will provide information about invasive species to be included in "Welcome Aboard" packages for incoming Navy personnel. Natural resources information includes the effects of alien plant and animal species to native ecosystems and federally-listed threatened and endangered or otherwise protected species.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
14	**Control alien plants:** The JBPHH IEPM will continue to evaluate and prioritize invasive noxious plants to be controlled, with emphasis on newly emerging weeds or those species or populations encroaching on healthy native plant populations and habitats, such as wetlands and native montane and mesic forests. The prevention and control of weed populations will continue to be incorporated into a written updates to the INRMP.	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
15	**Early detection roadside surveys:** The O'ahu Early Detection Program conducts roadside surveys of military installations in search of incipient invasive plants. This program is funded by the State Invasive Species Committees, and is operated out of the Bishop Museum. This program can be supported by providing access to program personnel on a regular basis (annually or less frequently).	Protected Species and Ecosystems Monitoring and Management (invasive species)	P2/C2
16	**Revegetation with native plants:** Restored and intact native habitats provide vital ecosystem services such as clean water, topsoil retention, and nesting and foraging areas for native species. When practicable, native species from O'ahu (preferably JBPHH locations) will be used in landscaping, replanting, recovery, and other conservation efforts. The JBPHH IEPM may promote participation with interested parties.	Protected Species and Ecosystems Monitoring and Management (natural resources restoration)	P2/C2

Table 9-6: Recommended Management Actions for Hickam (Continued)

Item No.	Recommendation	Management Action	Funding
17	**Permitting requirements for training and other activities in wetlands:** The purpose of this project is to ensure Section 401 and 404 compliance for training activities occurring in the ditched wetland in the Prime BEEF area.	Protected Species and Ecosystems Monitoring and Management (wetlands)	P2/NOC
18	**Habitat enhancement at Hickam wetlands:** The purpose of this project is to monitor wetland habitat and restore native vegetation in wetlands on Hickam including the Fort Kamehameha wetland, Āhua Reef high-value wetland area, and the banks and mouths of the conveyance canals Kumumau and Manuwai. At Āhua Reef, a project to increase the setback from the water for vehicle access will be investigated. Recreational enhancement will be provided by a shoreline interpretive trail. Restrictions will be placed on unleashed dogs at Āhua Reef. Projects are to be coordinated with the base landscape architect, the grounds maintenance program, and base planners. Recreational trail enhancements and pet restrictions are to be coordinated with MWR.	Protected Species and Ecosystems Monitoring and Management (wetlands)	P2/C2
19	**Watercourse sediment removal feasibility study:** The purpose of this project is to determine the level of hazardous chemical contamination in sediments found in the streams and canals, evaluate alternative methods for safe sediment removal with minimal release of entrained wastes, and develop a plan and budget estimate for sediment removal and subsequent disposal. Funds for this project are to be provided by the Environmental Restoration Program or facilities maintenance program.	Protected Species and Ecosystems Monitoring and Management (wetlands)	Other
20	**Wetlands management:** The Navy will continue its wetlands management policies described in Section 3.4.1.6. These include protecting wetlands from dredging, filling, or otherwise destroying without proper permits and necessary minimization and mitigative measures (i.e., no net loss of wetlands). In addition, the Navy will coordinate any wetland enhancement efforts with appropriate federal and SOH agencies. The Navy will continue to promote wetlands mitigation banking. The Navy will continue to ensure that planning staff receive formal, annual training on wetlands regulations and policy in order to properly identify, manage, and protect installation wetlands in accordance with "no net loss of wetlands" values.	Protected Species and Ecosystems Monitoring and Management (wetlands)	P2/NOC
21	**INRMP annual and 5-year updates:** Continue to update Navy metrics builder, meet with INRMP Working Group Members, and update document as required.	Natural Resources Studies	P2/C2
22	**Natural resource GIS data management:** JBPHH will continue to manage, integrate, access and report natural resources GIS data into JBPHH GIS database (Section 2.4), with major inputs anticipated during 5-year floral/faunal survey updates associated with INRMP revisions. GIS data will also be continually uploaded into RSIMS for early planning by facilities managers.	GIS	P2/C2
23	**Develop a GIS layer for mature and significant trees and landscapes:** The Navy will develop a GPS-based GIS map layer indicating the location of known mature and significant trees and landscapes that could be included in CNRH's geodatabase.	GIS/Forestry	P3/C3
24	**Protect mature and significant trees, landscapes, and pocket forests:** Facility managers from JBPHH will be required to get approval from the JBPHH XO prior to removing any tree within the installation (Section 3.4.4). Species of trees that are invasive would not be protected. In cases where the tree provides an important function (shade, for example) replacement with a non-invasive tree will be considered. JBPHH will prepare an instruction for this requirement.	Forestry/Land Management	P2/NOC

Table 9-6: Recommended Management Actions for Hickam (Continued)

Item No.	Recommendation	Management Action	Funding
25	**Urban tree inventory:** A comprehensive tree inventory will be conducted to confirm the species, location, diameter at breast height (4.5 feet above-ground level on high side), condition, maintenance requirements, location of adjacent utilities, such as overhead power lines or underground lines, and damage to adjacent landscape (sidewalks, roads, etc.) which has been caused by a particular specimen. The locations of trees will be digitized from the GLDP maps using a GeoBase. Tree locations will be confirmed in the field using hand-held Global Positioning System (GPS) units.ith 50,000-60,000 trees at Hickam AFB, such an inventory will be a major work effort. Each individual performing the inventory may collect data from 150 to 700 trees per day, depending on experience of the individual, stand uniformity, species variation, etc. Prioritizing areas for inventory will allow for phasing of the project. This project will assist in maintaining Tree City USA designation.	Forestry	Other
26	**Continue standard landscape provisions in construction/landscape contracts:** Continue to include standard provisions in all construction and landscape contracts regarding procedures to follow when working near mature and/or significant trees and landscapes (Section 3.4.4). Contract landscapers will also be instructed to plant non-invasive species when choosing plants for ornamental purposes. Species can be checked for potential high risk at www.wra.org or hpwra@yahoo.com.	Forestry/Land Management	P2/NOC
27	**Promote awareness of ESA- and other protected species and natural resources stewardship:** The Navy will continue to promote awareness of ESA- and other protected species and natural resources stewardship among JBPHH personnel and residents through on-going educational efforts such as printed material in "Welcome Aboard" packet, signs in ecologically sensitive areas (e.g., wetlands, forests), promotion of community service projects and beach cleanups, and brochures selected locations.	Community Outreach	P3/NOC
28	**Bird watching guide**: This project calls for the development through MWR of a bird watching guide for recreational users of the Āhua Reef and adjacent open areas along the coast.	Outdoor Recreation	P3/C3
29	**Continue to promote public outdoor recreation events:** The Navy will continue to promote public events at Hickam.	Outdoor Recreation	P3/NOC
30	**Continue to promote swimming, surfing, body boarding, jogging, bicycling, and picnicking:** MWR will continue to promote swimming, surfing, body boarding, jogging, bicycling, and picnicking at Hickam's recreational beaches .	Outdoor Recreation	P3/NOC
31	**Base planning:** A routine procedure will continue to be implemented to assure coordination among facilities planners, resource managers, SOH, and county officials. The JBPHH IEPM will continue to be the point of contact to provide relevant information on issues with potential to affect waterbirds, such as sound levels, direct habitat loss due to clearance and construction, proximity to neighboring habitats, and sensitivity of the birds to disturbance. Natural resources surveys may be required and mitigation measures developed to assure protection of federally-listed threatened and endangered or otherwise protected species and their habitats.	Land Management	P2/NOC

Table 9-6: Recommended Management Actions for Hickam (Continued)

Item No.	Recommendation	Management Action	Funding
32	**Landscape design:** The JBPHH IEPM will continue to evaluate all future landscape design and installation projects for the potential to include habitat restoration and the use of native plants whenever possible. The preference for native plant materials from O'ahu, as well as the importance of using sterile soil to prevent the introduction of pests such as nematodes, will continue to be emphasized. When choosing plants for landscape design, landscapers will consult the Weed Risk Assessment (WRA) (www.hear.org/wra) to ensure the species area not potentially invasive. The WRA analyzes a species' biology and history in Hawai'i to determine if it poses a high risk of becoming invasive. Species not listed on the website can be assessed for potential high risk by contacting hpwra@yahoo.com.	Land Management	P2/NOC
33	**Prevention of point source pollution:** The Navy will continue the current policy of pollution reduction for Hickam, including the identification of sources of pollutants in the harbor and their reduction/elimination.	Land Management	P2/NOC
34	**Soil stabilization and erosion control:** The Navy will continue to utilize BMPs during earthwork, construction, and the design of storm drainage systems.	Land Management	P2/NOC
35	**Land management restrictions during training maneuvers:** The Navy will continue to prohibit vehicle traffic off existing roads, use of rocks from rock piles or walls for training purposes, establishment of new vehicle tracks during training maneuvers. In addition, during training maneuvers, digging, including entrenchments and foxholes, will continue to be prohibited, except in areas specifically designated by the training coordinator. No new placement of barbed wire or concertina wire near signs marking the presence of sensitive ecological areas or fences will be allowed by personnel during maneuvers. No road, trail, or fire break clearing will be allowed during training maneuvers without permission from the training coordinator. No grading or construction of buildings or other permanent structure will be allowed without permission from the training coordinator.	Land Management	P2/NOC
36	**Law enforcement.** A conservation officer will be hired to enforce natural resources and other environmental compliance-related laws, regulations, and instructions	Law Enforcement	P2/NOC/C2
37	**Continue FFD and/or HFD response to any wildland fires:** Any wildland fires at all JBPHH facilities will continue to be addressed by the appropriate fire departments.	Wildland Fire	P2/NOC
38	**Emergency fire fighting by personnel during training exercises:** In case of fire during personnel training exercises, all fires will be reported to the FFD and personnel will stop training and begin to fight the fire. Personnel will continue to fight the fire until released by the fire department.	Wildland Fire	P2/NOC

9.4 ENVIRONMENTAL PLANNING AND MISSION SUSTAINABILITY

The natural resources management for JBPHH focuses management efforts and available funding on priority projects and tasks while setting clear conservation priorities. It also provides a standard against which to measure the effects of decisions made in the INRMP update.

9.5 ACHIEVING NO NET LOSS OF MILITARY MISSION

Through the implementation of this INRMP, JBPHH would experience no net loss in achieving its military mission. None of the actions proposed would take away training or operations capabilities.

9.6 USE OF COOPERATIVE AGREEMENTS

The JBPHH IEPM effectively cooperates with federal and SOH agencies in the management of natural resources at JBPHH installations. The USDA-WS provides predator control for the Niuli'i Ponds. USFWS cooperates with the JBPHH IEPM for the maintenance of PHNWR Waiawa and Honouliuli Units. JBPHH IEPM work with DLNR in the removal of feral pigs from the NCTAMSPAC Wahiawa in order to combat soil erosion, prevent the further loss of native vegetation, and protection of base personnel and residents.

9.7 NEPA COMPLIANCE

As discussed in Section 1.5.2, NEPA compliance for this INRMP was achieved through a Categorical Exclusion. All of the INRMPs being updated in this INRMP were previously reviewed as NEPA environmental assessments (EA). Finding of No Significant Impact were received by all of the INRMP EAs.

9.8 FUNDING

Because the INRMP is a public document that requires the mutual agreement of the installation and Working Group members, it is important to have a common understanding regarding projects contained in the plan that are most likely to be funded under existing policy. INRMP funding reflects an annual strategy that addresses legal requirements. As the Working Group defines objectives, identifies legal drivers, and collaborates with each other to develop land management goals, the subsequent outcome is a list of projects necessary to implement the INRMP. This project list includes "must fund" compliance-type projects as well as stewardship-type projects.

The DOD budget process includes four classes (C0 through C3) which are explained in Table 9-1 (Section 9.1). "Must fund" conservation requirements are those projects and activities that are required to meet recurring natural and cultural resources conservation management requirements or current legal compliance needs, including EOs. Under the Navy funding classification system, these are environmental readiness level (ERL) 4 projects (Table 9-6). INRMPs also include valid projects and programs that enhance an installation's natural resources, promote proactive conservation measures, and support investments that demonstrate Navy environmental leadership and proactive environmental stewardship. These projects will fall under ERL 1, 2, or 3 in the Navy classification system (Table 9-6).

Table 9-7: Navy Funding Classification System

Navy Funding Classification System	DOD Budget Process Class	Description
ERL 4	C0	Supports: (1) all actions specifically required by law, regulation, or EO (DOD Class 1 and 2 requirements) just in time; and (2) recurring administrative, personnel, and other costs associated with managing environmental programs that are necessary to meet applicable compliance requirements. Examples include development and revision of INRMPs; baseline surveys for INRMP development and revision; salaries and training of professional personnel developing and implementing INRMPs; biological surveys to determine population status of endangered, threatened, and sensitive species; survey and monitoring programs to support the migratory bird rule, wetlands surveys for planning, monitoring, and/or permit applications; and erosion control measures required to remain in compliance with natural resources protection regulations and to maintain land condition for realistic training operations.
ERL 3	C2	Supports: (1) all capabilities provided by ERL 4; (2) existing Navy executive agent responsibilities, participation in OSD sponsored inter-department and inter-agency efforts, and OSD mandate regional coordination efforts; (3) proactive involvement in the legislative and regulatory process to identify and mitigate requirements that will impose excessive costs or restrictions on operations and training; and (4) proactive initiatives critical to the protection of Navy operational readiness.
ERL 2	C2	Supports: (1) all capabilities provided under ERL3; (2) enhanced proactive initiatives critical to the protection of Navy operational readiness; (3) all Navy and DOD requirements; and (4) investments in pollution reduction, compliance enhancement, energy conservation, and cost reduction.
ERL 1	C2 and C3	Supports: (1) all capabilities provided under ERL2; (2) proactive actions required to ensure compliance with pending/strong anticipated laws and regulations in a timely manner; and (3) investments that demonstrate Navy environmental leadership and proactive environmental stewardship.

There are restrictions on how different Navy funding sources for natural resources management can be used. The following are the primary funding sources for Navy natural resources programs: (1) Operations and Maintenance, Navy (O&MN) funds; (2) Legacy funds; (3) forestry revenues; (3) agricultural outleasing; (4) fish and wildlife fees; (5) recycling funds; and (6) non-DOD funds.

O&MN Environmental Funds. The majority of natural resource projects are funded with O&MN environmental funds that are programmed through the Environmental Program Requirements (EPR) process. These appropriated funds are the primary sources of resources to support must-fund, just-in-time environmental compliance (ERL 4 projects). O&MN funds are generally not available for ERL1 through ERL3 projects. Only the initial procurement, construction, and modification of a facility or project are considered valid environmental funding requirements. In addition, when natural resources are tied to a specific construction project or other action, funds for the natural resource requirements should be included in the overall project costs.

The Navy prepares environmental program requirements submissions for consideration during the development of the Baseline Assessment Memorandum (BAM). The BAM is a direct input to the programming phase of the Planning, Programming and Budgeting and Execution System (PPBES) cycle. PPBES is a two-year budget cycle (1) Program Objective Memorandum (POM)

is used to submit programming proposal during even numbered (on-budget years) identifying the total program resources for six years; and (2) Program Review (PR) addresses urgent issues during odd number (off budget years) and proposed program increases must be offset by proposed program decreases. A two year program cycle is shown in Table 9-12. This INRMP provides Navy leadership with a fully validated minimum funding requirement to comply with all applicable environmental laws and implementing regulations.

Table 9-8: Navy Program Funding Cycles

Two Year Program Cycle

(FY07=1 October 2006 to 30 September 2007)

P0M-10	PY FY06	CY FY07	BY FY08	BY FY09	PrY FY10	PrY FY11	PrY FY12	PrY FY13	PrY FY14	PrY FY15
PR-11	PY FY07	CY FY08	BY FY09	BY FY10	PrY FY11	PrY FY12	PrY FY13	PrY FY14	PrY FY15	

- Program Objective Memorandum (POM) - Even-numbered budget year
- Program Review (PR) - Odd-numbered off-budget year

Definitions
Fiscal year (FY) - 1 October to 30 September of each year.
Prior year (PY) - The fiscal year(s) prior to the current year.
Calendar year (CY) - The present fiscal/ execution year.
Budget year (BY) - The fiscal year(s) following the current year.
Program year (PrY) - The fiscal years following the budget years.

Legacy Funds. The DOD Legacy Resource Management Program (Legacy Program) is a special congressionally mandated initiative to fund military conservation projects. The Legacy Program can provide funding for a variety of conservation projects such as regional ecosystem management initiatives, habitat preservation efforts, invasive species control, monitoring and predicting patterns of migratory birds and animals. The availability of Legacy Program funds is uncertain early in the year and pre-proposals are due in March and submitted to the Legacy Program. All Legacy Program proposals are reviewed by the Navy chain of command prior to submittal to the Legacy Program Office for final project selection.

Forestry Revenues. Revenues from sales of forest products on Navy lands are a source of funding for natural resources management programs. The revenues provide funds for (1) Annual Navy Forest Funds; and (2) DOD Forestry Reserve Account. The Annual Navy Forest Funds support commercial forestry operations at installations. Forestry operations must be commercially viable to be eligible for these funds. Under the DOD Forestry Reserve account, revenues are first used to reimburse commercial forestry expense and then 40 percent of the

installation net proceeds for the fiscal year can be distributed to the state that contains the installation. Any remaining amount is transferred into the reserve account to be used to improve forest lands, fund unanticipated contingencies in the administration of forest lands and the production of forest products, and natural resources management that implements approved plans and agreements.

Agricultural Outleasing. Money collected through the leasing of Navy-owned property for agricultural use is directed back into the natural resources program and reallocated throughout the Navy by NAVFAC head quarters. These are the broadest-use funds available exclusively to natural resource managers. The funds must be used exclusively to fund natural resources management requirements and administrative expenses of agricultural and grazing leases. Revenues can be used for administrative expenses of agricultural lease; initiation, improvement, and perpetuation of agricultural outleases; and implementation of INRMP stewardship projects.

Fish and Wildlife Fees. In addition to state and federal licenses, the installation may issue permits and collect user fees for fishing, hunting, and trapping activities on base. These fees may only be used for protection, conservation, and management of fish and wildlife, including habitat improvements and related actions. Money received from these fees can only be spent on the installation where it was collected and they may accumulate over time.

Recycling Funds. Any installation with a qualified recycling program (QRP) may use proceeds for some types of natural resource projects. Proceeds must first be used to cover QRP costs. Up to 50 percent of the net proceeds may then be used for pollution abatement, pollution prevention, composting, alternative fueled vehicle infrastructure support, vehicle conversion, energy conversion, or occupational safety and health projects, with first consideration given to projects included in the installation's pollution prevention plan. Remaining funds may be transferred to the non-appropriated MWR account for approved programs, or retained to cover anticipated future program costs. Natural resources projects can be funded as pollution prevention/abatement (e.g., wetlands or riparian forest restoration) or MWR projects (e.g., trail construction and maintenance).

Non-DOD Funds. Many grant programs are available for natural resources management projects, such as watershed management and restoration, habitat restoration, and wetland and riparian area restoration. When federally funded, these programs typically require non-federal matching funds. However, installations may partner with other groups to propose eligible projects.

Table 9-9: INRMP Ten-Year Fiscal Plan

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
A. PHNC Recommended Management Actions														**Section 9.3.1**
1. Regulatory agency coordination	PSEMM	P2/NOC	Costs included under normal operating costs											
2. Protected bird species management, monitoring and reporting	PSEMM	P2/C2	$8,000	$8,000	$9,000	$9,000	$10,000	$10,000	$10,000	$11,000	$11,000	$12,000	$98,000	Costs also cover B2, C2, D2, and E2
3.Hawaiian waterbird banding and resighting study	PSEMM	P2/C2	$0	$28,000	$0	$0	$0	$30,000	$0	$0	$0	$33,000	$91,000	Costs also cover B3, and E4
4. Hawaiian bat acoustic surveys	PSEMM	P2/C2	$15,000	$16,000	$16,000	$17,000	$18,000	$19,000	$20,000	$20,000	$21,000	$22,000	$184,000	Costs also cover B6 and C3
5. Hawaiian monk seal monitoring and protection	PSEMM	P2/NOC/ C2	Costs included under normal operating costs, A6, A7, A8, A9, A10, and A12											
6. Maintain/update SOPs for protection of ESA-protected species	PSEMM	P2/C2	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$3,000	$3,000	$3,000	$3,000	$24,000	Costs also cover B4, D4, and E6
7. Management actions for rare and protected species during training activities	PSEMM	P2/NOC/ C2	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$30,000	Costs also cover D5
8. Marine debris reduction	PSEMM	P2/NOC/ C2	$3,000	$3,000	$3,000	$3,000	$4,000	$4,000	$4,000	$4,000	$4,000	$4,000	$36,000	Costs also cover D6, and E8
9. Provide staff focused, annual natural resources training	PSEMM (natural resources awareness)	P2/C2	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$3,000	$3,000	$3,000	$3,000	$24,000	Costs also cover B14, C4, D8, and E7
10. Maintain security restrictions	PSEMM (access restrictions)	P2/NOC/ C2	Costs included under normal operating costs, A55											
11. Conserve Waiawa Watershed as a natural area	PSEMM (access restrictions)	P2/NOC	Costs included under normal operating costs.											
12. Predator control at PHNC	PSEMM (invasive species)	P2/C2	$70,000	$73,000	$76,000	$80,000	$83,000	$87,000	$91,000	$95,000	$100,000	$104,000	$859,000	Costs also cover B16, D11, E10
13. Pearl Harbor biosecurity plan	PSEMM (invasive species)	P2/C2	$0	$0	$120,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$190,000	Formal plan to be developed in fy14. Plan will be implemented in out years. Costs also cover E12

Table 9-9: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
14. Invasive species biosecurity SOPs	PSEMM (invasive species)/ Community Outreach	P2/C2	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$3,000	$3,000	$3,000	$3,000	$24,000	Costs also cover B17, C7, D12, E13
15. Control alien plants	PSEMM (invasive species)	P2/C2	$12,000	$13,000	$13,000	$14,000	$14,000	$15,000	$16,000	16,000	$17,000	$18,000	$149,000	Costs also cover B18, C8, D13, and E14
16. Mangrove and pickleweed removal in Pearl Harbor	PSEMM (invasive species and wetlands)	P2/C2	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$800,000	Costs also cover E9
17. Reduce and prevent the release of AIS	PSEMM (invasive species)	P2/NOC/ C2	$5,000	$0	$30,000	$0	$0	$0	$0	$0	$0	$0	$35,000	Costs include initial comp water sampling in fy12 and a comp water management plan developed in fy14.
18. Bilge and ballast purge	PSEMM (invasive species)	P2/NOC	Costs included under normal operating costs.											
19. Invasive algae control and early detection of incipient marine invasive species	PSEMM (invasive species)	P2/C2	$5,000	$5,000	$5,000	$56,000	$6,000	$6,000	$7,000	$7,000	$7,000	$7,000	$111,000	Costs include Gracilaria control in 2015 and annually recurring monitoring form incipient marine invasive species
20. Early detection roadside surveys	PSEMM (invasive species)	P2/C2	$5,000	$5,000	$5,000	$6,000	$6,000	$6,000	$7,000	$7,000	$7,000	$7,000	$61,000	Costs also cover B26, C9, D14, and E15
21. Revegetation with native plants	PSEMM (natural resources restoration)	P2/C2	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$100,000	Costs, also cover B27, C10, D15, and E16
22. Pearl Harbor wetland and riparian ecosystem restoration plan	PSEMM (natural resources restoration /wetlands)	P2/C2	$0	$0	$0	$0	$150,000	$0	$0	$0	$0	$0	$150,000	
23. Wetlands management	PSEMM (wetlands)	P2/NOC	Costs included under normal operating costs and A22											

Table 9-9: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
24. Update wetlands survey	PSEMM (wetlands)	P2/C2	$0	$0	$0	$0	$90,000	$0	$0	$0	$0	$90,000	$180,000	
25. INRMP annual and 5-year updates	Natural Resources Studies	P2/C2	$10,000	$10,000	$11,000	$80,000	$12,000	$12,000	$13,000	$13,000	$90,000	$14,000	$265,000	
26. Update/initiate installation-wide flora and fauna mapping	Natural Resources Studies	P2/C2	$0	$0	$0	$0	$75,000	$0	$0	$0	$0	$75,000	$150,000	Costs cover B31, C13, and D18
27. Update marine resources and fisheries survey	Natural Resources Studies	P2/C2	$26,000	$27,000	$28,000	$30,000	$31,000	$32,000	$34,000	$35,000	$37,000	$39,000	$319,000	
28. Study the effects of fishing on Pearl Harbor with a creel survey	Natural Resources Studies/ Outdoor Recreation	P3/C3	$0	$0	$18,000	$0	$0	$0	$0	$20,000	$0	$0	$38,000	
29. Coastal wetland and dryland restoration study	Natural Resources Studies	P3/C3	Alternate funding sources (e.g. Legacy)											
30. Feasibility study for aquatic invasive species control	Natural Resources Studies	P3/C3	$0	$0	$0	$0	$0	$0	$0	$20,000	$0	$0	$20,000	Pursue alternate funding sources
31. Natural resource GIS data management	GIS	P2/C2	$3,000	$3,000	$3,000	$3,000	$35,000	$4,000	$4,000	$4,000	$4,000	$40,000	$103,000	Costs also cover B33, C14, D19, and E22
32. Develop a GIS layer for mature and significant trees and landscapes	GIS/Forestry	P3/C3	$0	$0	$0	$0	$0	$40,000	$0	$0	$0	$0	$40,000	Costs also cover B34, C15, D20, and E23
33. Protect mature and significant trees, landscapes, and pocket forests	Forestry	P2/NOC	Costs included under normal operating costs.											
34. Continue standard provisions in construction/landscape contracts	Forestry/Land Management	P2/NOC	Costs included under normal operating costs.											
35. Promote awareness of ESA- and other protected species and natural resources stewardship	Community Outreach	P3/NOC	Costs included under normal operating costs through CNRH outreach coordinator											

Table 9-9: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
36. Support PHNWR Honouliuli and Waiawa Units	Community Outreach	P3/NOC	Costs included under normal operating costs											
37. Promote public education on hazards of fish consumption	Community Outreach	P3/NOC/ C3	Costs included under normal operating costs through CNRH outreach coordinator and encroachment coordinator, and through hiring of a conservation officer A54											
38. Support identification and mitigation of public health risks	Community Outreach	P3/NOC	Costs included under normal operating costs											
39. Water and sediment quality and public health	Community Outreach	P2/C2	Costs included under EV Compliance program											
40. Continue to support a public overlook at PHNWR Honouliuli Unit	Community Outreach	P3/NOC	Costs included under Regional Environmental Coordinator program											
41. Adopt a waterfront	Community Outreach	P3/NOC	Costs included under normal operating costs through CNRH outreach coordinator and encroachment coordinator											
42. Storm-water stenciling	Community Outreach	P3/C3	Costs included under EV compliance program											
43. Protect fishpond walls	Community Outreach	P2/C2/ NOC	Costs included under A16 and normal operating costs through the CNRH outreach coordinator											
44. Continue to support Rainbow Bay Marina	Outdoor Recreation	P3/NOC	Costs included under MWR program											
45. Continue recreational catch-and-release fishing and study the effects of fishing on the harbor	Outdoor Recreation	P3/NOC/ C3	Costs included under MWR program and A28											
46. Continue to support bicycling, jogging, and walking	Outdoor Recreation	P3/NOC	Costs included under MWR program											
47. Continue to promote public outdoor recreation events	Outdoor Recreation	P3/NOC	Costs included under MWR program											
48. Hunting ungulates for outdoor recreation	Outdoor Recreation/ Land Management	P3/C3	$12,000	$5,000	$5,000	$6,000	$6,000	$6,000	$7,000	$7,000	$7,000	$7,000	$68,000	Costs also cover B20 and C6. B20 is a P2/C2 project
49. Base planning	Land Management	P2/NOC	Costs included under normal operating costs.											
50. Landscape design	Land Management	P2/NOC	Costs included under normal operating costs.											

Table 9-9: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
51. Prevention of point source pollution	Land Management	P2/NOC	Costs included under EV Compliance program											
52. Soil stabilization and erosion control	Land Management	P2/NOC	Costs included under EV Compliance program											
53. Replant eroded landscapes	Land Management	P2/C2	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$15,000	
54. Land management restrictions during training maneuvers	Land Management	P2/NOC	Costs included under normal operating costs.											
55. Law enforcement	Law Enforcement	P2/NOC/ C2	$0	$0	$80,000	$84,000	$87,000	$91,000	$95,000	$100,000	$104,000	$109,000	$750,000	Costs include salary for Conservation Officer. Cost covers B45 , C24, D32 and E36
56. Maintain security fencing and firebreaks	Wildland Fire	P2/NOC	Costs included under normal operating costs.											
57. Emergency fire fighting by personnel during training exercises	Wildland Fire	P2/NOC	Costs included under normal operating costs.											
58. Monitor off-site development	Leases and Encroachment Management	P2/NOC	Costs included under normal operating costs under CNRH Encroachment coordinator											
59. Agricultural outleases	Leases and Encroachment Management	P3/C3	$0	$0	$0	$0	$0	$0	$0	$65,000	$0	$0	$65,000	Costs also cover B45
B. Lualualei Recommended Management Actions														**Section 9.3.2**
1. Regulatory agency coordination	PSEMM	P2/NOC	Costs included under normal operating costs.											
2. Protected bird species management, monitoring and reporting	PSEMM	P2/C2	Costs included in A2											
3. Hawaiian waterbird banding and resighting study	PSEMM	P2/C2	Costs included in A3											
4. Maintain/update SOPs for protection of ESA-protected species	PSEMM	P2/NOC	Costs included in A6											

Table 9-9: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
5. O'ahu 'elepaio monitoring and management	PSEMM	P2/C2	$4000	$4,000	$4,000	$5,000	$5,000	$5,000	$5,000	$5,000	$6,000	$6,000	$49,000	
6. Hawaiian bat acoustic surveys	PSEMM	P2/C2	Costs included in A4											
7. NAVMAG Lualualei Hawaiian picture wing fly and arthropod surveys	PSEMM	P2/C2	$25,000	$26,000	$27,000	$29,000	$30,000	$31,000	$33,000	$34,000	$36,000	$37,000	$308,000	
8. NAVMAG Lualualei stream bioassessments	PSEMM	P2/C2	$5,000	$5,000	$5,000	$6,000	$6,000	$6,000	$7,000	$7,000	$7,000	$7,000	$61,000	
9. Amastra cylindrical management	PSEMM	P2/C2	$30,000	$31,000	$33,000	$34,000	$36,000	$37,000	$39,000	$41,000	$43,000	$45,000	$369,000	
10. Achatinella mustelina management	PSEMM	P2/C2	$8,000	$8,000	$9,000	$9,000	$10,000	$10,000	$10,000	$11,000	$11,000	$12,000	$98,000	
11. Monitoring and management of NAVMAG PH Lualualei Branch listed/candidate/species of concern plant species	PSEMM	P2/C2	$45,000	$47,000	$49,000	$51,000	$54,000	$56,000	$59,000	$61,000	$64,000	$67,000	$533,000	
12. Fencing and signage used to mark presence of rare and/or protected species	PSEMM	N2/C2	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$25,000	Costs also cover D9
13. Abutilon menziesii, Marsilea villosa, Cyperus trachysanthos monitoring and management	PSEMM	P2/C2	$7,500	$3,500	$3,500	$3,500	$3,500	$3,500	$4,000	$4,000	$4,000	$4,000	$41,000	
14. Provide staff focused, annual natural resources training	PSEMM (natural resources awareness)	P2/C2	Costs are included under A9											
15. Maintain security restrictions	PSEMM (access restrictions)	P2/NOC	Costs included under normal operating costs, A55.											
16. Predator control at Niuli'i Ponds	PSEMM (invasive species)	P2/C2	Costs are included under A12											
17. Invasive species biosecurity SOPs	PSEMM (Invasive Species)	P2/NOC	Costs included under A14											

Table 9-9: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
18. Control alien plants	PSEMM (invasive species)	P2/C2	Costs included under A15											
19. Monitor, control and exclude feral ungulates within SMAs	PSEMM (invasive species)	P2/C2	$12,000	$13,000	$400,000	$20,000	$400,000	$25,000	$400,000	$30,000	$400,000	$50,000	$1,750,000	
20. Hunting to control feral ungulates	PSEMM (invasive species)	P2/C2	Costs included under A48											
21. Euglandina control techniques	PSEMM (invasive species)	P2/C2	$0	$0	$30,000	$30,000	$0	$0	$0	$0	$0	$0	$60,000	
22. Chameleon detection and control	PSEMM (invasive species)	P2/C2	$0	$0	$0	$0	$30,000	$30,000	$0	$0	$0	$0	$60,000	
23. Native habitat management through invasive vegetation removal at SMAs in NAVMAG Lualualei	PSEMM (invasive species)	P2/C2	$80,000	$84,000	$87,000	$91,000	$95,000	$100,000	$104,000	$109,000	$114,000	$119,000	$983,000	
24. Black-stem borer research	PSEMM (invasive species)	P2/C2	$0	$0	$0	$0	$0	$0	$30,000	$30,000	$0	$0	$60,000	
25. Peafowl seed predation study	PSEMM (invasive species)	P2/C2	$0	$0	$0	$0	$0	$0	$0	$0	$15,000	$0	$15,000	
26. Early detection roadside surveys	PSEMM (invasive species)	P2/C2	Costs are included under A20											
27. Revegetation with native plants	PSEMM (natural resources restoration)/Land Management	P2/C2	Costs are included under A21											
28. Wetlands management	PSEMM (wetlands)	P2/NOC	Costs included under normal operating costs.											
29. Niuli'i Ponds Management	PSEMM (wetlands)	P2/C2	$12,894	$7,000	$8,000	$8,000	$8,000	$9,000	$9,000	$10,000	$10,000	$10,000	$86,000	.
30. INRMP annual and 5-year updates	Natural Resources Studies	P2/C2	Costs are included under A25											

Table 9-9: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
31. Update/initiate installation-wide flora and fauna mapping	Natural Resources Studies	P2/C2	Costs are included under A26											
32. Dryland forest restoration studies	Natural Resources Studies	P3/C3	Alternate funding sources (e.g. Legacy)											
33. Natural resources GIS data management	GIS	P2/C2	Costs included under A31											
34. Develop a GIS layer for mature and significant trees and landscapes	GIS	P3/C3	Costs included under A32											
35. Protect mature and significant trees, landscapes, and pocket forests	Forestry	P2/NOC	Costs included under normal operating costs.											
36. Continue standard provisions in construction/landscape contracts	Forestry/Land Management	P2/NOC	Costs included under normal operating costs.											
37. Promote awareness of ESA- and other protected species and natural resources stewardship	Community Outreach	P3/NOC	Costs included under normal operating costs through CNRH outreach coordinator											
38. Base planning	Land Management	P2/NOC	Costs included under normal operating costs.											
39. Landscape design	Land Management	P2/NOC	Costs included under normal operating costs.											
40. Prevention of point source pollution	Land Management	P2/NOC	Costs included under normal operating costs.											
41. Soil stabilization and erosion control	Land Management	P2/NOC	Costs included under normal operating costs.											
42. Law enforcement	Law Enforcement	P2/NOC/ C2	Costs included under A54											
43. Continue FFD and/or HFD response to any wildland fires	Wildland Fire	P2/NOC/ C2	$0	$0	$65,000	$0	$0	$5,000	$0	$0	$5,000	$0	$75,000	Plan development in 2014; 3-year reviews.
44. Monitor off-site development	Wildland Fire	P2/NOC	Costs included under normal operating costs through CNRH encroachment coordinator.											

Table 9-9: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
45. Agricultural outleases	Leases and Encroachment Management	P2/NOC	Costs included under A58.											
C. NCTAMSPAC Wahiawa Recommended Management Actions														**Section 9.3.3**
1. Regulatory agency coordination	PSEMM	P2/ NOC	Costs included under normal operating costs											
2. Protected bird species management, monitoring and reporting	PSEMM	P2/C2	Costs included under A2											
3. Hawaiian bat acoustic surveys	PSEMM	P2/C2	Costs included under A4.											
4. Provide staff focused, annual natural resources training	PSEMM (natural resources awareness)	P2/C2	Costs are included under A9											
5. Maintain security restrictions	PSEMM (access restrictions)	P2/NOC	Costs included under normal operating costs, A54.											
6. Hunting to control feral ungulates	PSEMM (invasive species)	P2/C2	Costs are included under A47											
7. Invasive species biosecurity SOPs	PSEMM (invasive species)	P2/C2	Costs are included under A14											
8. Control alien plants	PSEMM (invasive species)/Land Management	P2/C2	Costs are included under A15											
9. Early detection roadside surveys	PSEMM (invasive species)	P2/C2	Costs are included under A20											
10. Revegetation with native plants	PSEMM (natural resource restoration)	P2/C2	Costs are included under A21											
11. Wetlands management	PSEMM (wetlands)	P2/NOC	Costs included under normal operating costs.											

Table 9-9: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
12. INRMP annual and 5-year updates	Natural Resources Studies	P2/C2	Costs are included under A25											
13. Update/initiate flora and fauna mapping	Natural Resources Studies	P2/C2	Costs are included under A26											
14. Natural resource GIS data management	GIS	P2/C2	Costs are included under A31											
15. Develop a GIS layer for mature and significant trees and landscapes	GIS/Forestry	P3/C3	Costs are included under A32											
16. Protect mature and significant trees, landscapes, and pocket forests	Forestry /Land Management	P2/NOC	Costs included under normal operating costs.											
17. Continue standard provisions in construction/landscape contracts	Forestry/ Land Management	P2/NOC	Costs included under normal operating costs.											
18. Promote awareness of ESA- and other protected species and natural resources stewardship	Community Outreach	P3/C3	Costs included under normal operating costs through the CNRH outreach coordinator											
19. Continue to support jogging, walking, hiking	Outdoor Recreation	P3/C3	Costs included under normal operating costs											
20. Base planning	Land Management	P2/NOC	Costs included under normal operating costs.											
21. Landscape design	Land Management	P2/NOC	Costs included under normal operating costs.											
22. Prevention of point source pollution	Land Management	P2/NOC	Costs included under normal operating costs through EV Compliance program											
23. Soil stabilization and erosion control	Land Management	P2/NOC	Costs included under normal operating costs.											
24. Law enforcement	Law Enforcement	P2/NOC/ C2	Costs included under A55.											
25. Continue FFD and/or HFD response to any wildland fires	Wildland Fire	P2/NOC	Costs included under normal operating costs.											

Table 9-9: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
26. Monitor off-site development	Leases and Encroach-ment Management	P2/NOC	Costs included under normal operating costs.											
D. Kalaeloa Recommended Management Actions														**Section 9.3.4**
1. Regulatory agency coordination	PSEMM	P2/NOC	Costs included under normal operating costs.											
2. Protected bird species management, monitoring and reporting	PSEMM	P2/C2	Costs included under A2											
3. Hawaiian monk seal protection	PSEMM	P2/NOC/ C2	Costs included under normal operating costs, A6, A7, A8, A9, A10, and A12											
4. Maintain/update SOPs for the protection of ESA-protected species	PSEMM	P2/C2	Costs are included under A6											
5. Protection of rare and/or protected species during training:	PSEMM	P2/NOC	Costs included under A7											
6. Marine debris reduction:	PSEMM	P2/NOC	Costs included under A8											
7. Kalaeloa akoko management	PSEMM	P2/C2	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$3,000	$3,000	$3,000	$3,000	$24,000	
8. Provide staff focused, annual natural resources training	PSEMM (natural resources awareness)	P2/C2	Costs included under A9											
9. Fencing and signage used to mark presence of rare and/or protected species	PSEMM (access restrictions)	P2/C2	Costs are included under B12											
10. Access restrictions	PSEMM (access restrictions)	P2/NOC	Costs included under normal operating costs, A55											
11. Predator control at Nimitz and White Plains beaches	PSEMM	P2/C2	Costs included in A12											
12. Invasive species biosecurity SOPs	PSEMM (invasive species)	P2/C2	Costs included under A14											

Table 9-9: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
13. Control alien plants	PSEMM (invasive species)	P2/C2	Costs included under A15											
14. Early detection roadside surveys	PSEMM (invasive species)	P2/C2	Costs included under A20											
15. Revegetation with native plants	PSEMM (natural resources restoration)	P2/C2	Costs included under A21											
16. Wetlands management	PSEMM (wetlands)	P2/NOC	Costs included under normal operating costs.											
17. INRMP annual and 5-year updates	Natural Resources Studies	P2/C2	Costs are included under A25											
18. Update/initiate flora and fauna mapping	Natural Resources Studies	P2/C2	Costs included under A26											
19. Natural resource GIS data management	GIS	P2/C2	Costs included under A31											
20. Develop a GIS layer for mature and significant trees and landscapes	GIS/Forestry	P3/C3	Costs included under A32											
21. Protect mature and significant trees, landscapes, and pocket forests	Forestry/ Land Management	P2/NOC	Costs included under normal operating costs.											
22. Continue standard provisions in construction/landscape contracts	Forestry/ Land Management	P2/NOC	Costs included under normal operating costs.											
23. Promote awareness of ESA- and other protected species and natural resources stewardship	Community Outreach	P3/C3	Costs included under normal operating costs through CNRH outreach coordinator											
24. Continue to promote public outdoor recreation events	Outdoor Recreation	P3/NOC	Costs included under normal operating costs											

Table 9-9: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
25. Continue to promote swimming, surfing, body boarding, jogging, bicycling, and picnicking	Outdoor Recreation	P3//NOC	Costs included under normal operating costs											
26. Base planning	Land Management	P2/NOC	Costs included under normal operating costs											
27. Landscape design	Land Management	P2/NOC	Costs included under normal operating costs											
28. Prevention of point source pollution	Land Management	P2/NOC	Costs included under normal operating costs.											
29. Soil stabilization and erosion control	Land Management	P2/NOC	Costs included under normal operating costs.											
30. Land management restrictions during training maneuvers	Land Management	P2/NOC	Costs included under normal operating costs.											
31. Floodplains	Floodplains	P2/NOC	Costs included under normal operating costs.											
32. Law enforcement	Law Enforcement	P2/NOC/ C2	Costs included under A55											
33. Continue FFD and/or HFD response to any wildland fires	Wildland Fire	P2/NOC	Costs included under normal operating costs.											
34. Emergency fire fighting by personnel during training exercises	Wildland Fire	P2/NOC	Costs included under normal operating costs.											
E. Hickam Recommended Management Actions														**Section 9.3.5**
1. Regulatory agency coordination	PSEMM	P2/NOC	Costs included under normal operating costs											
2. Protected bird species management, monitoring, and reporting	PSEMM	P2/C2	Costs included under A2											
3. BASH support for Hickam Airfield	PSEMM	P2/C2	$5,000	$5,000	$5,000	$6,000	$6,000	$6,000	$7,000	$7,000	$7,000	$7,000	$61,000	
4. Hawaiian waterbird banding and resighting study	PSEMM	P2/C2	Costs included under A3											
5. Hawaiian monk seal protection	PSEMM	P2/NOC/ C2	Costs included under normal operating costs, A6, A7, A8, A9, A10, and A12											

Table 9-9: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
6. Maintain/update SOPs for the protection of MBTA and ESA-protected species	PSEMM	P2/C2	Costs included under A6											
7. Provide staff focused, annual natural resources training	PSEMM (natural resources awareness)	P2/C2	Costs included under A9											
8. Āhua Reef cleanup	PSEMM (natural resources restoration)	P2/C2	Costs included under A8											
9. Mangrove removal	PSEMM (invasive species)	P2/NC2	Costs included in A16											
10. Predator control	PSEMM (invasive species)	P2/C2	Costs included under A12											
11. Exotic fish eradication	PSEMM (invasive species)	P2/C2	$0	$0	$0	$0	$0	$45,000	$0	$0	$0	$0	$45,000	
12. Hickam biosecurity plan	PSEMM (invasive species)	P2/C2	Costs included under A12											
13. Invasive species biosecurity SOPs	PSEMM (invasive species)	P2/C2	Costs included under A14											
14. Control alien plants	PSEMM (invasive species)	P2/C2	Costs included under A15											
15. Early detection roadside surveys	PSEMM (invasive species)	P2/C2	Costs included under A20											
16. Revegetation with native plants	PSEMM (natural resources restoration)	P2/C2	Costs included under A21											
17. Permitting requirements for training and other activities in wetlands	PSEMM (wetlands)	P2/NOC	Costs included under normal operating costs											

Table 9-9: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
18. Habitat enhancement at Hickam wetlands	PSEMM (wetlands)	P2/C2	$30,000	$31,000	$33,000	$34,000	$36,000	$5000	$5000	$5000	$6000	$6000	$191,000	
19. Watercourse sediment removal feasibility study	PSEMM (wetlands)	Other	Costs included under the IRP or facilities											
20. Wetlands management	PSEMM (wetlands)	P2/NOC	Costs included under normal operating costs											
21. INRMP annual and 5-year updates	Natural Resources Studies	P2/C2	Costs are included under A25											
22. Natural resource GIS data management	GIS	P2/C2	Costs included under A31											
23. Develop a GIS layer for mature and significant trees and landscapes	GIS/Forestry	P3/C3	Costs included under A32											
24. Protect mature and significant trees, landscapes, and pocket forests	Forestry/Land Management	P2/NOC	Costs included under normal operating costs.											
25. Urban tree inventory	Forestry	Other	Costs are included under the ground maintenance budget											
26. Continue standard provisions in construction/landscape contracts	Land Management	P2/NOC	Costs included under normal operating costs.											
27. Promote awareness of ESA- and other protected species and natural resources stewardship	Community Outreach	P3/NOC	Costs are included under the normal operating costs through the CNRH outreach coordinator											
28. Bird watching guide	Outdoor Recreation	P3/C3	$0	$0	$0	$0	$6,000	$0	$0	$0	$0	$0	$6,000	
29. Continue to promote public outdoor recreation events	Outdoor Recreation	P3/NOC	Costs included under normal operating costs											
30. Continue to promote swimming, surfing, body boarding, jogging, bicycling, and picnicking	Outdoor Recreation	P3/NOC	Costs included under normal operating costs											
31. Base planning	Land Management	P2/NOC	Costs included under normal operating costs.											

Table 9-9: INRMP Ten-Year Fiscal Plan (Continued)

Objectives and Projects	Management Action	Funding Class	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total	Comments
32. Landscape design	Land Management	P2/NOC	Costs included under normal operating costs.											
33. Prevention of point source pollution	Land Management	P2/NOC	Costs included under normal operating costs through EV Compliance program.											
34. Soil stabilization and erosion control	Land Management	P2/NOC	Costs included under normal operating costs.											
35. Land management restrictions during training maneuvers	Land Management	P2/NOC	Costs included under normal operating costs.											
36. Law enforcement	Law Enforcement	P2/NOC/ C2	Costs included under A55.											
37. Continue FFD and/or HFD response to any wildland fires	Wildland Fire	P2/NOC	Costs included under normal operating costs.											
38. Emergency fire fighting by personnel during training exercises	Wildland Fire	P2/NOC	Costs included under normal operating costs.											

PSEMM – protected species and ecosystem management and monitoring
P2/NOC – Priority 2/Normal Operating Costs
P2/C2 - Priority 2/ Class 2 Funding
P3/C3 – Priority 3/Cass Funding

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CHAPTER 10
REFERENCES AND RESOURCES

CHAPTER TEN REFERENCES AND RESOURCES

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5-1	NCTAMSPAC Wahiawa	HHF
5-2	Camp Stover Housing Community	CNRH
6-1	Nimitz Beach	HHF

CHAPTER 11

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CHAPTER ELEVEN: PREPARERS AND CONTRIBUTORS

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